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Prodigal Waste of Technical Effort

IF WITHIN the experience of a single executive the waste of technical effort on experimental projects has run into millions of dollars, due to "the lack of timely cost estimation," the total waste chargeable to this cause must reach a staggering sum. Here, apparently, is a field for conservation, the fertility of which is equalled only by the simplicity of the method of cultivation, as Mr. Becket pointed out in his presidential address before the American Electrochemical Society. His theme will repay the most thoughtful consideration.

THE lack of perception by scientists and engineers of the financial, business and economic aspects of technical problems is not a new theme. But the weight of evidence warrants reiteration and emphasis of the simple fact that, in the development of industrial processes, ingenious technology is futile if commercial cost is not counted and found favorable. Apparently the technologist is still prone to concentrate his effort on the knotty technical problem, spending time and money in its solution, only to have some more mature and experienced man put a finger on the vital spot of excessive cost.

HOWEVER intriguing a problem in industrial research, however ingenious the method of attack, however skillful the experimentation, however beautiful the results, the task still remains to translate these things into production and yield a profit. Hence the cost must be counted; otherwise expensive raw materials, power, wages and methods of marketing may suddenly be found to nullify all that has previously been done. Mr. Becket cites convincing examples that will suggest similar incidents in the experience of those who deal with honest and enthusiastic experimenters and inventors.

THE theme has its educational aspects. The time to instil the principles of engineering economics and cultivate a sense of their importance is during undergraduate student days. Fortunately for the future of chemical engineering this fact is perceived by progressive teachers who, by means of problems, laboratory work, theses and special lectures direct the student's attention to the economic as well as the technical phases of engineering. Such efforts should be systematically extended until no chemical engineering graduate escapes inoculation.

WHEN that time comes, fewer experimental projects in chemical engineering will meet the fate of those that have already been tried and found "over-invented and under-engineered." Unbridled technical enthusiasm will be curbed by the bit of economic feasibility. There will be no less demand for technical skill and ingenuity, imagination and inventiveness; but they will be conserved and directed toward goals that offer reasonable opportunity for achievement. Progress will be more substantial when we learn to count the cost, and count it early rather than late.

Congressional Rodeo And Muscle Shoals

JUST when it began to appear that Congress had succeeded in roping the obstreperous 7-year old from Muscle Shoals and had it safely tied down according to its justly famous political procedure, the knot began to slip. Senator Norris, hurrying back from a week's round-up on the Tennessee River Ranch, starts to wave the red flag of government ownership. Senator Heflin, equally picturesque whether as a broncho-buster or in a filibuster, rides the Air Nitrates Corporation back into the ring and insists that it should be the center of attraction. Representative James of Michigan, vice-chairman of the joint congressional committee on arrangements, protests that the performance is not proceeding according to the rules of his committee and that not enough ballyhoo has been given to his pet sideshow, "Nitrates for Farmers and Fighters." The fertilizer industry apparently thinks that it's able to take care of that end of the show business and is kicking because Congress is going to let some outsider come in and invest $20,000,000 in an industry that is already "over-capacity-ized." So the "greatest show on earth" proceeds in its own inimitable way with every prospect of a continuous stand until the end of the spring season and with the usual promise of a revival next fall on a scale "bigger and better" than ever before.

But if Congress has turned the whole Muscle Shoals issue into a three-ring circus, the fault is entirely its own. From the very first it has refused to listen to those in a position to bring about careful and impartial study of the problem. The viewpoints of the President in his oft-repeated recommendations, of the engineering minority in the recent Muscle Shoals Inquiry and the countless representations made by disinterested individuals and organizations have all been thrown overboard and Congress has insisted on making the matter a political issue to be handled by the usual procedure of bluster and buncombe. That political opposition should develop is natural, and the resulting indecision and delay, inevitable.

This much can be said of the present situation. The favored bid of the Muscle Shoals power and fertilizer companies is a frank attempt to meet practically all of the objections that have been raised against its previous offers. It has played its part according to the instructions that have been handed to it. If Congress now refuses to run the show according to its own rules, industry in general can well afford to withdraw and watch the pitiful performance from a comfortable seat in the grandstand.

Protection for the American Technologist

ONE of Theodore Roosevelt's slogans was "America for Americans," which at first glance seems nothing more than an empty patriotic gesture, the purpose of which was purely political. But interpreted in another way, the statement has fundamental economic significance—that those who would come to this country merely for the sake of the comparatively lucrative rewards in the practice of their technical profession should by the same token seek citizenship with its attendant obligations.

Within the past five years especially, there has been definite evidence of an influx of foreign chemists and technologists, who under one guise or another, enter for the ultimate purpose of getting jobs in our industries. It is true that many of these aliens are poorly trained professionally, and are of course, unwelcome under any circumstances; but many are well trained and it is concerning the latter group that we are moved to make comment. Entering ostensibly to take needed graduate study, the well-trained foreign chemist is able to establish a measure of prestige, acclimate himself, and at the end of a year or two, either secure an assistantship, or possibly a responsible industrial position. Then by taking convenient trips home at vacation time, he maintains his status as a "visitor." Or, he may have been admitted in the quota for his country, as belonging to a learned profession. The whole scheme is exceedingly clever—but withal is very much to the detriment of the American chemist, who more than a few times is in direct competition with a "visitor" or temporary resident who is eager to accept any salary within reason, rather than attempt to market his services for a sum commensurate with our own standards of living.

At no period in our peacetime industrial history has the ample supply of well-trained American chemists and engineers been employed to maximum advantage in industry, and a better appreciation of this group, and a consequently better remuneration, is not far distant—in fact much already has been accomplished in this direction. But an uncontrolled external competition surely will deal a severe blow to all movements for improving the economic status of our technical men.

The practical remedies for this deplorable state of affairs are several. One plan, the systematic registration of alien visitors, has been discussed in an able and commendable manner in one of the issues of *Industrial & Engineering Chemistry*. However, as an expedient and involving no legislation, we believe American chemical industry should refuse permanent employment to alien chemists if equally competent home talent is available. This would be a simple and effective way of encouraging our own technologists and of improving their none too enviable position.

A New Literature of Chemical Engineering

ONE of the marks of a solid, well-defined profession is a heritage of approved practice, the principles and information of which are assembled in systematic periodical literature and in books.

It is but natural that the profession of chemical engineering, with its remarkably rapid growth and breadth of interest, should have attained its present position among the major branches of engineering still lacking a well-rounded book literature. But the time has come when such a literature, particularly in the English, can and should be prepared, and this task already had been begun, as is announced in the news columns of this issue.

In order to plan and to produce a chemical engineering series of the maximum utility, detailed comments and suggestions regarding both subjects and authors are desired. On behalf of the advisory committee and publishers, *Chem. & Met.* will be glad to receive such assistance from its readers.

Fertilizer Industry Again Hard Hit

DURING January and February of this year the fertilizer industry was most enthusiastic as to the prospects for business. Large increase in sales over the preceding season seemed assured and corresponding preparation was made by the purchase of raw material and preliminary manufacture of mixed goods. One reflection of this optimism was shown in the stiffening of prices for ammonium sulphate and other fertilizer constituents which advanced in price until the middle of winter.

About Christmas time, though not recognized until later, there began two important economic influences that now seem to spell great disappointment for the fertilizer business. Cotton and cotton futures sagged in price, because of the prospect of an exceptional carry-over. It is now estimated that about 5,000,000 bales will be carried over into the next season, whereas the normal carry-over is 3,500,000 bales. About the same time the New York stock market and the Florida land booms both found a tight rein drawn upon them and reaction in stock prices and land prices was the inevitable and, to many, the rather startling consequence. Under such circumstances all classes of credit were reduced, including that to the bankers and distributors who do the local fertilizer financing throughout the South. As a result of these two major influences, cheaper cotton and tighter credit, an optimistic February has passed and a pessimistic April and May are following.

It is none too soon for others whose business interlocks with that of sulphuric acid, fertilizer constituents and the fertilizer trade generally, to take account of stock and see what will happen to them. Lower prices for ammonium sulphate have already been noted and this is but one of the many consequences that must be considered. There is no ground for general fear or industrial pessimism, but caution against embarrassing entanglements with the fertilizer trade is certainly in order.

All who had so strongly hoped for a return of the fertilizer business to real prosperity will share with that industry in its disappointment at these unexpected developments. Let us trust that they represent but a temporary setback. But even as a temporary matter they are most unwelcome.

Will Platinum Prices Break?

THE INITIAL discovery, less than three years ago of platinum in the Waterberg district of the Transvaal, has been followed by the disclosure of extensive lode deposits in the Lydenburg and Potgietersrust areas. These new resources, the first of importance revealed in recent years, are likely to have a profound effect on the price of this much-sought metal.

In 1912 the world's production of platinum was 279,036 oz., of which 250,000 oz. came from the Ural mines of Russia. In 1924 the total output was only 104,525 oz., in spite of Colombia's record production of 51,331 oz. As a consequence, prices rose from about $40 an oz. in 1912 to an average of $119 an oz. in 1924. Russia, formerly the chief source of platinum, is still in a severe depression, and immediate recovery is not expected. So much for recent production history.

Resources and present operations in the Transvaal have been described by A. W. Newberry in the May 1 and 8 issues of *Engineering and Mining Journal-Press.* So great are estimated resources that Mr. Newberry believes the Transvaal capable of supplying "As much as the world can consume."

Production costs are difficult to estimate, since nearly all of the world's supply heretofore has come from placer mines and hence there is practically no background of metallurgical experience with the sulphides from which the metal has to be separated in the Transvaal. Assuming a 3-dwt. ore, and with mining costs comparable to those of the Witwatersrand, refined platinum should cost $52 an oz., says Mr. Newberry. In addition to the lode deposits, two of which are approximately 75 miles in length, there is a possibility of finding alluvial deposits of consequence.

Coming at a time when Russian production is potentially capable of at least a six-fold increase over the 1924 output, the authoritative estimate of the vast Transvaal resources by Mr. Newberry forecasts a probable decline of platinum prices from the present figure of $110 an oz. to $60 to $70 within the next 5 years. However, in view of the estimated production cost of $52 an oz. in the Transvaal, it is unlikely that platinum prices ever will be on a parity with those of gold.

Not Afraid of Failure

"WE'LL try anything once and if it doesn't succeed we'll keep on trying it. But once we're convinced the process won't succeed, we're not ashamed to admit our failure." The superintendent of a middle western refinery was thus accounting for a partly dismantled battery of cracking stills that stood apart from the other equipment as a sort of rusty monument to some misdirected effort of the past. Obviously, here had been a waste of effort and money that might have been avoided by thorough research and development. Yet, strangely, the thing that impressed us most was not the futility of this particular effort that failed, but rather the spirit of daring with which the problem had been tackled. Here in this willingness to take a chance seemed to be the underlying philosophy of the progressiveness that had been responsible for the remarkable development of technology which has come to characterize the Mid-Continent petroleum industry.

Put out to shift for himself the technical man in this industry has developed an attitude of unusual independence and self-reliance. The problems that have come to him have not been of a sort that could easily be referred to the engineering department of the home office for orderly solution through the processes of research and study. Usually they have had to be solved immediately and using only the men and equipment directly at hand. Sometimes, to be sure, this attitude of self-reliance on the part of the technical man, has worked out less favorably because of failure to take advantage of knowledge and experience that might easily be available from outside sources. A case in point is in connection with the bubble-cap type of fractionating equipment that is now being widely adopted in oil refineries. The principles and operation of these columns are well known for they have long been used

in other industries. Their design is no longer patentable and since construction is fairly simple, many homemade columns have been installed of size and type varying with the whim of the builder. Some may have been carefully designed from an adequate knowledge of the engineering principles involved but others are frankly guesses based on experience with other types of overhead equipment. Some of the latter class are scarcely more efficient than the old type of dephlegmators they have displaced. Doubtless a few years hence many of these will be standing by as monuments to experimentation that might not have been necessary had the experimenters been better informed of the principles of fractional distillation or willing to take the advice of those with long experience in this field.

But the encouraging commentary on the whole situation—and one that cannot escape the attention of even the most casual visitor in the industry—is that the engineer is indisputably in control of every phase of production. His influence is not confined to a consulting or advisory capacity. He has reached a position of complete responsibility because he has demonstrated that he is able to handle the job better than anyone else. He is boss—not so much because of training and experience—but because he gets results at a time when results are sorely needed.

Engineering Graduates and Executive Positions

AT THIS SEASON of the year, several thousand seniors and graduate students of engineering schools are negotiating for that "first job." About 30 per cent of these will enter positions of junior executive grade, and the remaining 70 per cent will begin duties that are purely technical in nature. How can these young men qualify for executive positions of high responsibility? This question was answered by prominent industrial executives at a recent meeting of the Founder Societies at the Engineering Societies Building, New York City.

Fundamentally, according to E. M. Herr, president of the Westinghouse Electric & Manufacturing Co., executive work calls for ability to direct the efforts of others and this is something that essentially is an inborn quality. "Telling the student of engineering that executive ability is inborn and cannot be created out of nothing will no more discourage him than it does to tell a student of music that unless he has talent for music he cannot become a virtuoso or an operatic star," was one of the high lights in Mr. Herr's talk.

F. B. Jewett, vice-president of the American Telephone & Telegraph Co., also stressed the importance of character as an executive prerequisite, saying that the qualities constituting character come into the world with the man himself. Dr. Jewett emphasized the point that as many of the answers to business difficulties lay in the physics of the problems and not in business principles, the head of a large engineering corporation should be an engineer rather than a business man. He has little chance if he has no knowledge of what might at any time be a matter of vital and major importance in solving his problems, without such an appreciation.

H. A. Guess, managing director, American Smelting & Refining Co., and John C. Parker, vice-president and chief engineer of the Brooklyn Edison Co., concurred in the belief that engineers at least got their just share of high executive positions. There was also a belief on the part of the speakers that the technical part of the curricula of our engineering colleges was overemphasized.

To the engineering student about to enter industry, or to the young graduate engineer already possessed of some experience, *Chem. & Met.* commends the observations of these seasoned men of industry. Certainly if an engineer aspires to lead and to direct the work of others, he should first of all be a gentleman, possessing those innate qualities that mark a man capable of carrying the mantle of authority, and further than this there is the natural technique of executive control that Mr. Herr mentioned. To be sure professional excellence is one of the prerequisites; but to those desirable personal attributes is the greatest weight accorded when executive capacity is being rated. Let the young graduate of 1926 think this over.

Two Kinds of Specifications

SPECIFICATIONS to be useful must be both significant and enforceable. There need be no conflict between these two requirements; but unfortunately sometimes one and sometimes the other consideration dominates or is alone considered. For example, there are specifications which are apparently significant, but for which there are no means of checking or enforcing the requirements as samples cannot be taken or analyses made to prove compliance or violation. On the other hand, there are other specifications which can be checked accurately, with analyses expressed to the second decimal place, but when the answer is obtained showing that the goods pass or do not pass we still are no better off. In such cases the goods which do pass may be no better, in fact they may be worse, than other goods which would not pass. Such result is noted only when the specifications are not really significant as to usefulness or quality.

In the case of gasoline standards and specifications we have somewhat too long remained under the influence of specifications built for the convenience of laboratory testing. It is high time that we reconsidered what these specifications are for and drafted a new set of requirements accurately to reflect the performance characteristics of automotive fuel. As a first step toward that end it is important to understand what we want gasoline to do for us when we put it into a motor car. A fundamental and thorough analysis of this subject is presented in this issue of *Chem. & Met.* and we recommend it to the careful study of every engineer even remotely interested in this subject.

In preparing this study Dr. H. C. Dickinson, of the Bureau of Standards, has rendered a real service to the petroleum industry. Perhaps some of the members of that industry will say "There is nothing new in all this." But such a person will really be deceiving only himself. It is not newness which we want at this stage. It is an accurate, significant summary that will stimulate a re-viewing of the needed requirements.

It might be well if some other industries would make a similar analysis for themselves and their problems.

Sulphur, Pyrites and the Price of Sulphuric Acid

AS COMPETITIVE raw materials for sulphuric-acid manufacture, brimstone and pyrites have had an interesting and significant history that may well bear repeating as a result of recent developments in the chemical markets. In the early days all sulphuric acid was made from brimstone and even as late as 1882 about 85 per cent of the production was from that material. By 1895 the percentage had dropped to 75 however, and then began a 5-year period that saw the almost complete surrender of brimstone to pyrites and other sulphur-bearing materials. Zinc smelters began in 1895 to recover acid as a byproduct and in 1907 the copper blast-furnace plants followed the same course. By 1914 the total acid production was divided among the following sources: domestic and foreign pyrites 73.7 per cent, zinc smelters 13.2 per cent, copper smelters 10.5 per cent and sulphur 2.6 per cent.

A few years later, war-time expansion, partial cutting off the imports of Spanish pyrites, labor scarcity and a large increase in the output of the domestic sulphur mines combined to upset the existing order. New plants were designed and built exclusively for brimstone and attractive concessions were made to persuade pyrites users to follow the same practice. By 1918 the sulphur-pyrites ratio had jumped to 48:28 in favor of sulphur and except for a short period of uncertainty in 1919—when the acid makers were waiting for the sulphur producers to decide the important question of price policy—brimstone continued its ascendency. At present two-thirds of all acid made in this country is from sulphur, one-sixth from pyrites and another sixth from the smelters.

Accordingly the problem of sulphur vs. pyrites appeared until recently to have been settled in favor of the elemental material. It was easier to handle, cheaper to burn, left no cinder with its disposal problem, gave a purer acid under most circumstances, and, all in all, if properly priced was decidedly more attractive. As might be expected, however, the matter of cost is an all determining factor and the recent increase in the price of sulphur—open quotations have advanced from $14 per long ton at the mine to $19—has served to re-open the issue, calling for a careful analysis of the comparative merits and costs of each material. During the War when it was necessary to establish figures for the relative value of brimstone and pyrites to the acid maker, the Government estimated that considering all operating costs, brimstone was worth an average of 3 to 4 cents per long ton unit more for acid manufacturing purposes than sulphur in pure pyrite (carrying 40 to 43 per cent of sulphur). This assumed that the consumer received nothing for his pyrite cinder. Obviously these figures must vary with the different plants depending upon their location with reference to the pyrites deposits or to sea- or lake-ports, the possibility of selling cinder, local labor rates, the cost of installing new equipment, the size of the plant and to a lesser extent the use to be made of the acid. It is apparent, however, that this differential in cost now assumes determining importance as each acid maker arrives at his own solution of the sulphur vs. pyrites problem for his particular plant.

The action of the sulphur producers in increasing the price was not entirely unexpected. For more than two years the original mine of the oldest of the three producers has been closed down. Domestic production has exceeded—although sometimes by a very slight margin—our consumption every year since 1917, but there has been a growth in sulphur exports for which it was necessary to draw on existing stocks. Thus total shipments from the mines in 1924 exceeded production by 316,784 tons and in 1925 by 448,730 tons. During the same period Sicilian stocks, although no longer a factor in this market, were drawn on to the extent of 133,483 tons. From the viewpoint of the sulphur producer it is an open question whether or not this exhaustion of stocks is economically justifiable. There are essential uses for sulphur, such as in the vulcanization of rubber, in insecticide sprays, in petroleum refining and sulphite pulp production, for which there is no substitute or competitor. These uses must be served even if the sulphuric-acid maker is neglected. Furthermore there is always the possibility that new uses may be developed which would make sulphur too valuable a material to be used where byproducts or substitutes are available. Accordingly it would appear that there are sound economic reasons why an adequate reserve of sulphur—perhaps of several million tons—should be maintained in this country at all times.

It is not possible to predict with certainty the course of the developments that may result from the present situation. It is inevitable that sulphuric acid prices will rise and those who use this important chemical must resign themselves to an increased cost. Fortunately since this differential is capable of close checking there should be no "gouging" by the acid maker as he passes the burden onto the consumer. Just what this increase will mean to the fertilizer industry, already facing a crucial situation on sales and credits, remains uncertain, but the views expressed elsewhere in this issue by Charles H. MacDowell are indicative of the attitude with which the fertilizer manufacturer is tackling the sulphur problem. This industry has long been the largest user of sulphuric acid, consuming during 1925—according to figures just issued by the Department of Commerce—2,094,009 tons of the 50 deg. acid. Of this quantity, which represents about a third of the estimated total production in the United States during that year, 1,626,144 tons was produced within the fertilizer industry and the remainder was purchased from acid manufacturers. Since 1919 nearly all of the acid produced by the industry has been made from sulphur although the manufacturers of fertilizer chamber acid can use pyrites more profitably and to a greater extent than can the maker of contact and commercial strength acids where purity of both the gas and final product is more essential. To revert to pyrites, however, means a larger outlay than many in the fertilizer industry are prepared to make at this time.

In other lines of industry—for sulphuric acid touches on nearly all of them—there will doubtless be increased interest in other sources of sulphur. Whether or not another pyrites cycle is to follow the present brimstone cycle in the history of the sulphuric-acid industry may conceivably depend on economic conditions over which the acid maker has no control. It is more likely, however, that each case will have to be decided for itself on the basis of a thorough analysis of costs and operating conditions.

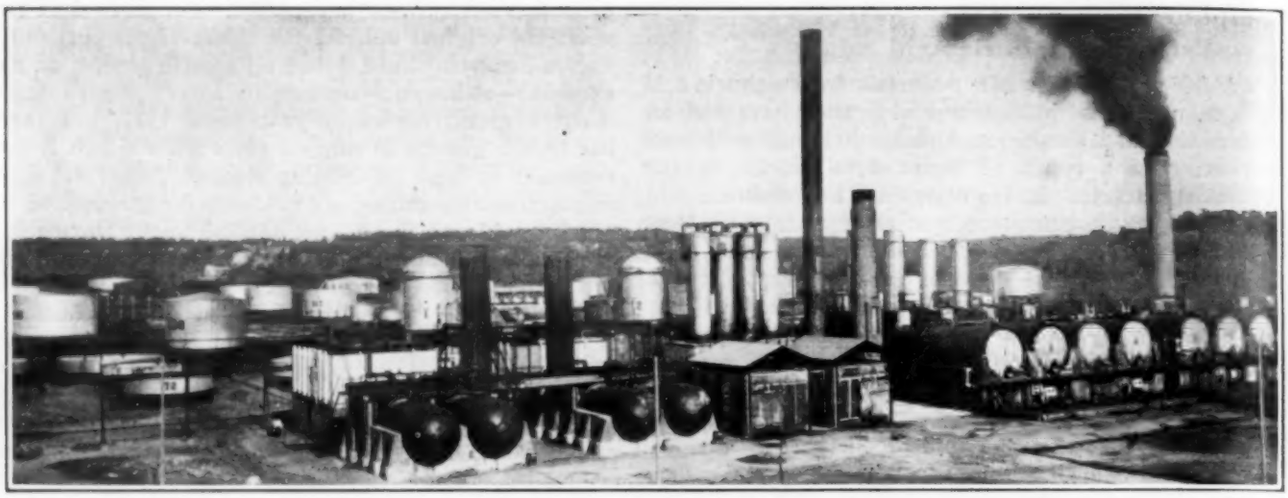


Fig. 1. A general view of a part of the refinery of the Pierce Petroleum Corporation near Tulsa, Oklahoma

Chemical Engineering Applications in an Oil Refinery

In modernizing its Sand Springs refinery the Pierce Petroleum Corporation has capitalized on much of recent progress in oil technology

By S. D. Kirkpatrick
Associate Editor, *Chem. & Met.*

AMONG technical men in the Mid-Continent field it is common opinion that the refinery of the Pierce Petroleum Corporation at Sand Springs, Okla., is one of the most progressive in the industry. Its reputation for high efficiency is attributed to able technical direction and supervision which in turn has been responsible for a comprehensive program of modernization of plant and equipment. This development has been characterized by the application of many of the most recent advances in the processes of chemical engineering, such, for example, as the use of efficient distillation and fractionation equipment, the construction of cracking units of latest design, and the adoption of the centrifugal process and the contact filtration method of refining lubricating oils. The boiler and power plants have been put on a thoroughly modern basis. Facilities have been provided for laboratory and semi-commercial research both on refining processes and on the utilization and testing of the products of the refinery. And as the accompanying photographs clearly indicate the plant has been made a model of neat appearance by "good housekeeping" and careful attention to details that are likely to be neglected in the prosecution of an urgent program for quantity production.

Pipe Still of Efficient Design

It has been said that the design and construction of pipe stills is an open game which offers the greatest opportunities for engineering skill in solving the distillation problems of the oil refiner. There are, therefore, almost as many designs and layouts of equipment as there are installations and the operating efficiencies of these units will doubtless vary over a wide range. The topping plant of the Pierce refinery, although made up to some extent of the usual commercial units, has nevertheless been carefully designed from an engineering standpoint to give the following results: high yield and throughput, fuel economy from efficient conservation of heat, and high quality of products from close fractionation and control of temperatures. There are two identical units in the topping plant, each of which is able to handle 3,500 to 4,000 bbl. of crude oil per day yielding about 60 per cent of the total charge in 3 overhead products—gasoline, kerosene and gas oil. The gasoline and kerosene are practically finished products, water-white and requiring only slight sweetening treatment to pass the usual doctor test. By a slight modification of the usual procedure it is possible to obtain in a single operation the so-called export gasoline having a gravity of 64 to 65 deg., as well as the usual product of New Navy specifications.

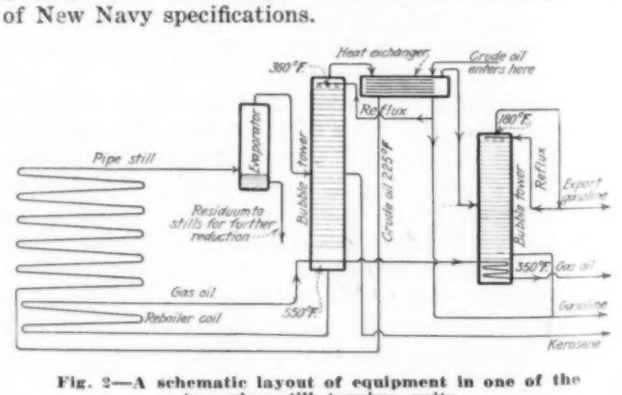


Fig. 2—A schematic layout of equipment in one of the two pipe still topping units
Attention is directed to the efficient provision for heat conservation and close fractionation of the different products

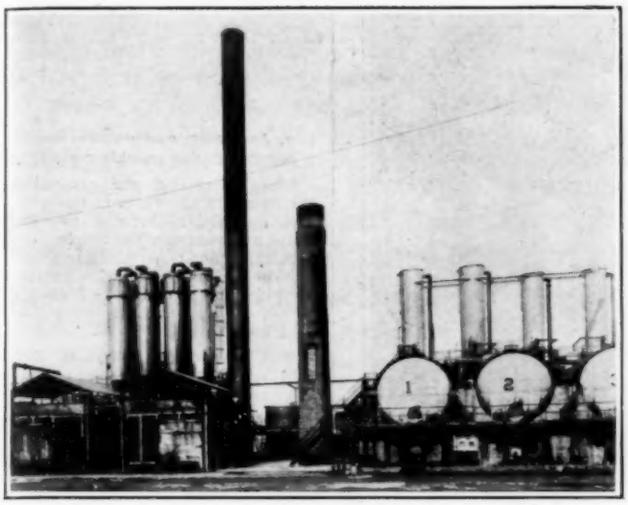


Fig. 3—Pipe still topping plant

Each of the two units shown at the left in this picture have a daily capacity of 4,000 bbl. of crude oil, from which sixty per cent is removed in the form of three practically finished products—gasoline, kerosene and gas oil. The residuum, while still hot, is pumped to the ten reducing stills, of which the first three are shown in this picture.

The operation of the pipe still and the interesting layout of the evaporator, fractionating tower and heat exchanger units may be observed from the diagrammatic sketch of Fig. 2. It will be noted that the crude oil enters the system through a Griscom-Russell vapor heat exchanger where its temperature is raised to approximately 225 deg. F., by the vapors from the top of the first bubble tower. It then enters the pipe still, each unit of which contains 154 tubes, 4 in. in diameter and 20 ft. in length, arranged in the furnace in the form of two coils. The vapors leave the furnace at 600 to 650 deg. F., and pass into an evaporator and then to the bubble tower, which is entered at one of the lower plates. About midway up the tower the kerosene fraction is withdrawn. From the bottom of the column, which is at a temperature of about 600 deg. F., a portion of the gas oil is withdrawn and further heated by passing through the reboiler coil in the furnace. It is then returned to supply additional heat at the bottom of the bubble tower in order to obtain close fractionation between the end point of the kerosene and the initial boiling point of the gas oil. The remaining gas oil flows through a closed coil in the base of the second bubble tower where it provides additional heat for fractionation and finally passes through cooling coils to storage.

The gasoline vapors that leave the top of the first bubble tower are at a temperature of about 360 deg. F. and as these pass through the vapor heat exchanger, in order to raise the temperature of the crude, a portion is condensed into gasoline. The uncondensed gasoline vapor passes off into the second bubble tower where it is fractionated into export gasoline and gasoline, the export gasoline being withdrawn from the top in vapor form and the gasoline being condensed and passing away at the bottom. The condensed gasoline from the vapor heat exchanger is partly utilized as a reflux at the top of the first bubble tower, the temperature of the gasoline vapors being automatically regulated and controlled by the amount of reflux being pumped over. In order to obtain the necessary end point on the export gasoline a portion of the condensed product is refluxed over the top of the second bubble tower, the quantity being regulated, as in the first tower, by automatic temperature controls.

In fact a noteworthy feature of this installation is the many uses of automatic control devices which greatly simplify the manual operation of the plant. Practically the only operating adjustment required is that on the fuel valves of the furnaces. Leeds and Northrup potentiometer type instruments are used to record temperatures at various important stages in the process, and the control of fractionation is by Tycos temperature regulating devices that automatically control the rate of reflux material at the top of the bubble columns. Charging and transfer pumps, which are housed beneath the condensers, are controlled by automatic float valves.

An innovation in operating procedure introduced at the Pierce plant is in passing the hot residuum from the topping plant directly to the reducing stills. It is claimed that this method decreases coke deposition and prevents excessive cracking which is reflected in a larger yield and better quality of lubricating stock. The battery of ten reducing stills is to be seen at the right of the pipe stills in Figs. 1 and 3.

The four Cross cracking units at the Pierce plant are of the latest design equipped with special bubble towers that permit the production of end-point gasoline direct from the process. The gas oil from the topping plant is cracked in the Cross stills to yield gasoline, recycle stock and fuel oil. The recycle stock is blended with the gas oil in equal proportions to form a satisfactory charging material for the process.

Contact Filtration of Lubricating Oil

Prior to the recent changes at the Pierce refinery the wax and lubricating oil plants were of the construction formerly regarded as standard in the industry, namely, refrigeration, cold settling, wax pressing and sweating. The refrigerating equipment has since been enlarged and the cold settling process eliminated by the use of centrifugal dewaxing machines. Five Sharples supercentrifuges of the type shown in Fig. 6 now produce an increased yield of a better quality of bright stock.

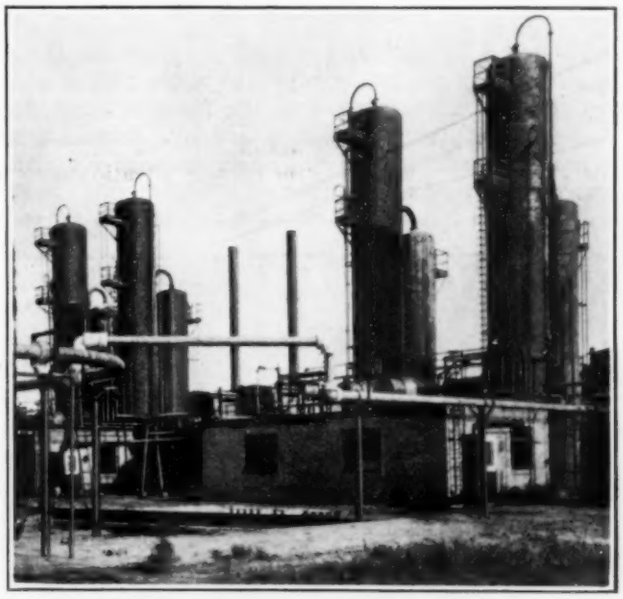


Fig. 4—Four Cross cracking units that have recently been completed

These units, each of which will handle 1,000 bbl. of cracking stock per day, are equipped with the latest design of bubble towers

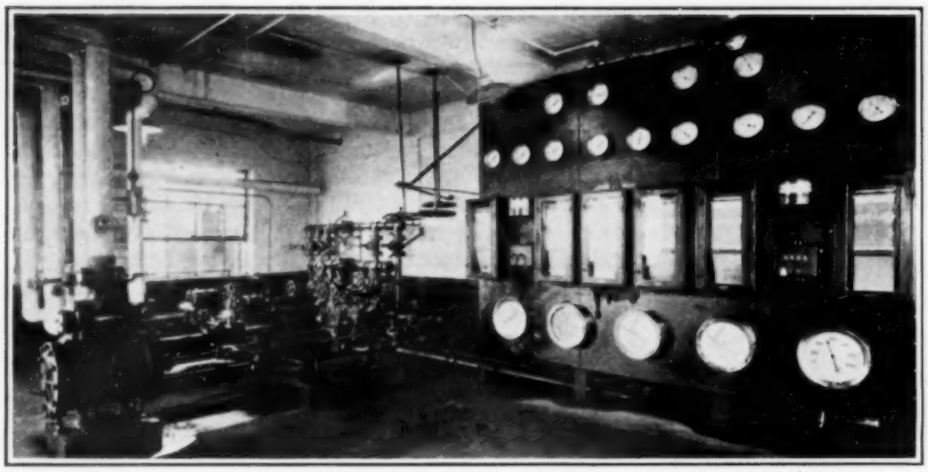


Fig. 5—Pump and control house for the Cross cracking plant

The indicating and recording instruments shown here not only give detailed records of production but greatly simplify the manual operation of the plant. At the left is one of simplex, double-acting high-pressure steam pumps for charging the cold gas oil to the still.

The addition of a 100-ton absorption atmospheric type refrigerating machine to the existing unit gives the plant a total refrigeration capacity of 250 tons. This is arranged in 2 units—one of which handles the stock for wax pressing, and the other for the centrifugal plant.

The percolating system of decolorizing lubricating stock, which has been used for many years in practically all refineries, has been displaced at the Pierce plant by the contact filtration process. As this method is used at Sand Springs the lubricating oils are first treated with acid and then without neutralization are mixed with fine fullers earth (100 mesh or finer) in a continuous mixer that automatically adds the desired proportion of clay. For filtering bright stocks this proportion is 1 volume of clay to 4 or 5 volumes of oil. The mixture is then heated to about 400 deg. F. in a pipe still and is passed to a specially designed agitator, where it is held at a high temperature and continuously agitated, in order to obtain the maximum decolorizing efficiency from the clay. After cooling the mixture is pumped through two Sweetland filters to remove the clay which may then be reactivated for further use.

Modern Power Plant

High and low pressure steam for processing the oil and for power generation is produced in a central boiler house that combines most of the features of modern power plant practice. Eleven 308 hp. Heine boilers, mounted as shown in Fig. 7, are equipped for either gas or oil firing at a rating of 200 per cent. Foster superheaters have been installed in each in order to provide 50 deg. superheat for the steam. The feed water, preheated to 210 deg. F. in an open-type Cochrane heater, is fed to the boilers by a 400 g.p.m. 3-stage centrifugal pump driven by a Terry steam turbine.

A significant feature is the use of control and indicating devices. Each boiler front is provided with a Republic flow meter which indicates its horsepower output and also records the proportion of the total steam flow supplied by each boiler. Similar instruments check up on the distribution of the different steam consuming uses. Temperature and pressure recording devices give additional plant records that greatly simplify operations in the boiler house. The adjoining power plant provides the electric current required for power and light purposes, although a connection to outside power is provided for emergency use. A 500-kw. single-stage turbine is direct connected to a 480-volt, 3,600 r.p.m. two-phase generator.

It is somewhat unusual to find a refinery of the size of the Pierce plant so well equipped with facilities for

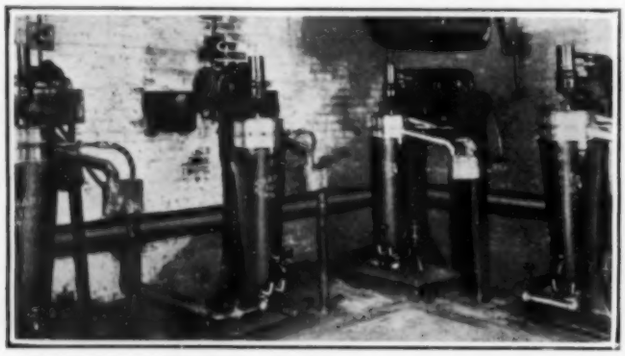


Fig. 6—Centrifugal dewaxing machines for the production of bright stock

This equipment has replaced the cold settling system formerly used, saving considerable time, floor space and capital investment

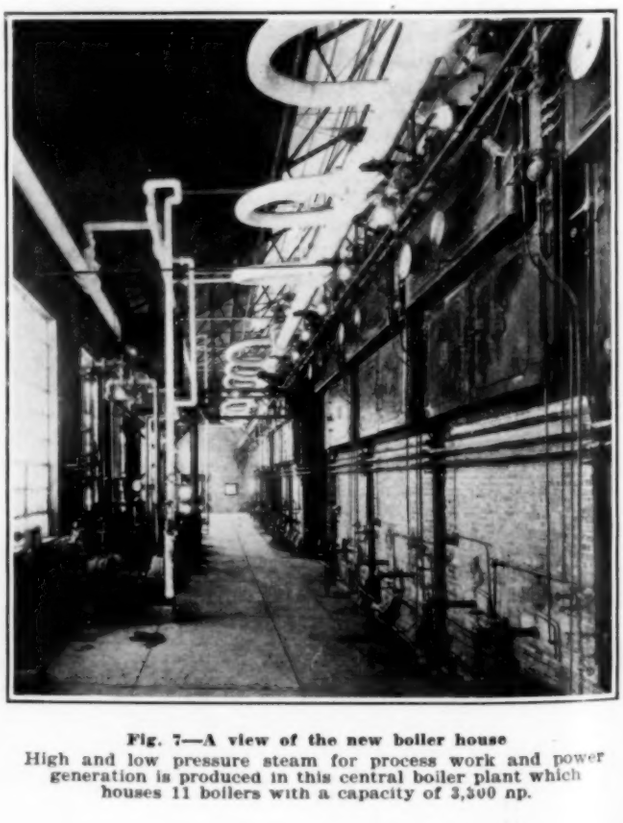


Fig. 7—A view of the new boiler house

High and low pressure steam for process work and power generation is produced in this central boiler plant which houses 11 boilers with a capacity of 3,300 hp.

laboratory research and plant scale development work. On the second floor of the 2-story building that has been provided for this work the company maintains a chemical laboratory for the control and testing of its products as well as office and library facilities for the staff. The ground floor is fitted up for development work and semi-commercial equipment is provided that makes it possible to duplicate under experimental conditions practically every process that is used in the refinery. A complete refrigerating, wax sweating and dewaxing plant was built as part of the research preceding the changes made on a much larger scale in the company's lubricating oil and wax plants. A recent acquisition is a dynamometer laboratory in which lubricating oils will be tested under actual conditions existing in automotive service.

Reference has previously been made to the neat appearance of the entire plant. Paint has been used to good advantage on all of the equipment. Storage tanks, light oil agitators and condensing equipment in which light oils are handled have been painted with aluminum paint which not only improves their appearance but materially reduces evaporation losses. The general superintendent of the manufacturing department, J. M. Wadsworth, has organized the refinery into a number of competitive districts, which are judged each week on the basis of "good housekeeping," which includes attention to safety and fire prevention, as well as to the maintenance of attractive working conditions.

The writer is indebted to Mr. Wadsworth, the superintendent, and to H. J. Robertson, chief chemist, for the privilege of inspecting the Pierce refinery. He desires also to express his thanks to C. O. Willson for the use of photographs and for other assistance in the preparation of this article.

Organic Glass—A New Plastic

RECENT publication in English of a pamphlet by Drs. Fritz Pollak and Kurt Ripper of Vienna, describing their work on carbamide-formaldehyde condensation products, has served to call attention in this country to the new organic glass substitute to which the inventors have given the name "Pollopas."

In addition to being colorless and transparent the new material is strong and takes on a peculiar brilliancy when its surface is polished. Tests made at the Physical Institute of the University of Vienna reveal that Pollopas does not absorb the ultra-violet rays normally withheld by glass. This property of the new colloid makes it appear not improbable that a therapeutic use might develop for hospital windows into which sunlight could penetrate to the full extent. The ultra-violet light rays are also of importance for the growth of plants and it is likely that greenhouses might offer another application of this material. The refractive index for Pollopas lies between 1.54 and 1.9, or in almost exactly the same range as flint glass. It has a hardness of about 2.95 on the Mohr scale, which classes it with materials that can readily be turned on the lathe. The specific gravity of the new colloid is about half that of glass, being 1.44. It has a crushing strength of 2,230 kg. per sq.cm., a tensile strength of 10 kg., and a bending strength of 510 kg. per sq.cm. Although not yet produced commercially, large-scale development work is being carried on at the artificial resin factory of Dr. Fritz Pollak in Vienna.

Research in Petroleum

FUNDAMENTAL research has been compared by W. F. Thom, Jr., of the Geological Survey to seed sown by the husbandman; some becomes stifled by unfavorable surroundings; some perishes for lack of support; some is destroyed because workers are tempted by financial rewards offered elsewhere; and some brings forth an hundred fold, giving the means of life and comfort. Research in applied science is the harvesting of the crop planted by fundamental research, and yields the grain which is immediately and profitably convertible into products satisfying human wants.

Speaking before the recent Oil and Gas Power National Conference in Washington Mr. Thom declared that probably the most important of the researches in applied science waiting to be carried through to completion are those in the fields of physics and chemistry, particularly the latter. Perfecting processes for "cracking" fuel oils and heavy crudes into gasoline has vitally modified the economic structure of the petroleum industry, and has in effect practically doubled the supply of crude oil available for gasoline manufacture, with a corresponding diminution in the volume of fuel oil which must be sold in competition with coal. And as fuel oil has been transformed from a mere byproduct into a raw material for gasoline manufacture, the near future may see the price of fuel oil independent of that of coal and governed only by the demand for gasoline.

Conserving Natural Gas

It is within the realm of possibility that commercially profitable methods may now be devised for effecting the chemical combination of the molecules of natural gas, or of the "fire damp" from coal mines, to form artificial gasoline, and it likewise seems quite possible that asphalts and asphaltic materials, which are oxidized and "dried up" oils, can be reconverted into liquid form by suitable treatment with hydrogen. Perhaps the method for making synthetic alcohol from artificial gas, now practiced in Germany, may be developed so as to be a commercial source of motor fuel; and the liquefaction of coal, the distillation of coal, and the retorting of oil shales, all are lines from any one of which important developments may come.

In practically all of these investigations for making substitutes for oil, the work of the chemist must be backed by that of the geologist and the chemical engineer. Whether it be natural gas, asphaltic material, coal, or oil shale, that is to form the raw material for the manufacture of synthetic motor fuel, both geology and engineering must be called upon to point out and provide the needed supplies, and physics as well as chemistry must be employed in the processes by which the desired transformation is to be accomplished. However, conceding the possibility that discoveries may be made by which any or all of the raw materials mentioned may become the source of cheap motor fuel, or of fuel oil, we must yet face the probability that no one of them can be counted on to yield the billions of gallons of motor fuel used annually in this country except at price levels vastly higher than those now obtaining. This, not so much because of our inability to make any or all of the chemical transformations suggested, as because it has not yet been demonstrated on an adequate scale that the costs of these transformations can be so reduced as to make their products commercially profitable at non-prohibitive prices.

Chlorine Symposium Features A. E. S. Meeting at Chicago

Electrochemists also discuss comparative merits of electric and gas-fired furnaces, proper plating metals and methods and other topics of industrial interest

Editorial Staff Report

THE OUTSTANDING feature of the 49th meeting of the American Electrochemical Society held at the Chicago Beach Hotel, April 22, 23 and 24, was the all-day session on the production and utilization of chlorine. In particular the discussion was most concerned with possible means of utilizing the overproduction that has characterized the chlorine industry since the war. As one of the members succinctly pointed out, "Dame Nature erred in the formula for salt: Had it been Na_2Cl there would be no overproduction of chlorine." The subject is of such far-reaching importance that it gave birth a few years ago to the Chlorine Institute, Inc., which is devoted exclusively to the problems of the chlorine industry. The Chicago symposium attracted world-wide attention and representatives from countries as far distant as Japan and Australia actively participated in the discussion.

President F. M. Becket opened the meeting by emphasizing briefly the wide scope and commercial and economic bearing of the subject. Thereupon he relinquished the chair to D. A. Pritchard, works manager of the Canadian Salt Co., under whose able guidance the symposium was prepared and conducted. In introducing the subject, Mr. Pritchard chose for his topic the "Economics of Chlorine." Beginning with its pioneers, Scheele and Davey, he briefly described the contributions to the industry of such men as Faraday, Berthollet, Watt, Tennant, LeBlanc, Dunlop, Weldon, Deacon, Hurter and Solvay. Scientific cell operation requires expert control, only economically feasible in a central plant serving a large number of consumers. Outlets for hydrogen include synthetic hydrochloric acid (in successful operation in England and at Windsor, Canada) ammonia, alcohols and hydrogenation of oils. Liquid chlorine was first commercially produced in 1888 by the Badische company.

J. M. Rowland, chief engineer of the Hooker Electrochemical Co. gave an account of the remarkable achievements in the transportation of the "golden fluid." The data submitted were the joint contribution by Mr. Rowland, H. P. Wells, technical director of the Electro Bleaching Gas Co., and H. M. Mabey, general traffic manager of the Mathieson Alkali Works. There are now in service 317 so-called class V tank cars. The tank is of hammer-welded construction, built of 0.75-in. plate, is 52.5 in. in diameter by 28.5 ft. long, and has a volumetric capacity of approximately 421 cu.ft. The tank by regulation is permitted a load of 30,000 lb. of liquid chlorine, which at 70 deg. F. (21 deg. C.) occupies 341 cu.ft., allowing a vapor space above the liquid of approximately 19 per cent of the total tank volume. The cars are designed, constructed and tested at 500 lb. hydrostatic pressure in accordance with the A.R.A. specifications. Walton S. Smith commented on the splendid record of one of these tank cars which has been in service 16 years, has traveled 300,000 miles and today there is no sign of internal corrosion.

The rapid development of the electrolytic alkali-chlorine industry in Japan was covered by four papers presented in person by Dr. Shuichiro Ochi, head of the Tokyo Imperial Industrial Laboratories, and Vice-President and Delegate of the Society of Chemical Industry of Japan. The first electrolytic chlorine was produced by the Hodogaya plant in 1915. The total capacity of bleaching powder production of Japan today is estimated at 112,572,000 lb. per year, while the capital invested is about $6,500,000. Most of the factories buy their electric power (water-power) at 2.5 sen (1.25 cents) per kw.-hr. About 40,000 tons of bleaching powder and 25,000 tons of caustic soda per year are manufactured in Japan today. The bleaching powder is all of electrolytic chlorine origin; 80 per cent of the caustic soda produced today is electrolytic as compared with 60 per cent in the United States.

Making High Test Bleaching Powder

Dr. Ochi and his assistant, Matsuo Nakkamura, have investigated the composition of bleaching powder and the mechanism of its formation. The formula $Ca(OCl)Cl.H_2O$ was proved not only by microscopic researches, but also by the measurement of the heat of solution, the heat of hydration and the aqueous vapor tension of the crystal. The mechanism of formation is considered as follows: At first an amorphous mass of mixed calcium salts of hydrochloric and hypochlorous acids and water is formed, then crystals of $Ca(OCl)Cl.H_2O$ separate out. When the chlorination is carried out at higher temperatures and quickly finished by cooling, the product is chiefly amorphous, while the slow chlorination at lower temperatures favors the formation of the crystalline variety. Presence of an excess of water retards the crystal development.

A further investigation on high test bleaching powder was carried out by Dr. Saburo Urano, engineer of the Asahi Electrochemical Works, Marunouchi, Tokyo. As the result of carefully conducted experiments, Dr. Urano obtained and exhibited pure products of well-defined crystalline structure. Calcium hypochlorite, $Ca(OCl)_2$, and hydrated lime, $Ca(OH)_2$, combine to form crystalline basic calcium hypochlorite: $Ca(OCl)_2.2Ca(OH)_2$, when a definite condition of the liquid phase obtains. This compound gives a bleaching powder of higher available chlorine (40-48 per cent) and of greater stability than ordinary bleaching powder. By dissolving this basic salt in water, Urano obtained a calcium hypochlorite solution free from calcium chloride. By evaporation of the calcium hypochlorite solution in vacuo (25 to 50 mm. Hg, 30 to 40 deg. C.) he produced

calcium hypochlorite in a crystalline state purer than that made by any of the older processes. By drying the crystalline calcium hypochlorite Urano produced the highest test bleaching powder, containing 90 to 95 per cent available chlorine.

The behavior of silver-lead alloy anodes for chlorine cells has been studied by Colin G. Fink and L. C. Pan. An anode composed of approximately 61 per cent silver and the balance mostly lead operated for 510 hours in an experimental alkali-chlorine cell, showed a loss of practically zero as compared with a loss of over 2,000 grams per 1,000 ampere-hours for pure lead anodes, and 1,700 grams for pure silver anodes, when operated in the same cell. This remarkable drop in corrosion is attributed by the authors to a highly catalytic film on the surface of the lead-silver alloy anodes.

Research carried out by W. H. Martin and A. F. W. Cole of the University of Toronto has greatly clarified some of the peculiar properties exhibited by chlorine on exposure to light. Professor Abraham Lincoln Marshall submitted a detailed critical survey of the reaction: $H_2 + Cl_2 = 2HCl$. In summing up two types of mechanism of the reaction were advanced, one involving Cl atoms and the other activated molecular chlorine. Recent physical studies appear to indicate that light is able to dissociate chlorine into atoms. This view favors the atomic mechanism. The paper was discussed by Prof. J. Watson Bain and Dr. W. H. Martin of Toronto University. D. A. Pritchard of Windsor referred briefly to the successful commercial installation of the synthetic HCl plant of his company, the Canadian Salt Co., mentioning that the light from a mercury arc lamp has been found to be entirely satisfactory.

Chlorine in War and Peace

Major-General Fries opened the afternoon session of the chlorine symposium with a highly fascinating address on the use and importance of chlorine in chemical warfare. There is no one chemical which is more indispensable to the Service than chlorine. Chlorine forms the one essential raw material for a number of war gases. General Fries described the manufacture and properties of phosgene, mustard gas, lewisite, tear gases and toxic smokes. Among the disadvantages of chlorine in chemical warfare is the high vapor pressure necessitating containers of very rugged construction. Furthermore, about ten times as much chlorine is required to produce the same toxic effect as that of some of the other war gases. It is probable that chlorine as such will not be used in the future as a standard chemical warfare agent.

Following Major-General Fries, Lt.-Colonel H. L. Gilchrist, chief of the medical research division, Chemical Warfare Service, presented an illustrated lecture on the chlorine gas treatment in respiratory diseases. From a practical point of view, the evidence available does not indicate that the members of the medical profession are unanimous as to the effectiveness of chlorine gas treatment for respiratory diseases, hence it is a debatable question. Dr. Gilchrist has obtained excellent results from the use of chlorine in the treatment of certain respiratory diseases. But it is not recommended for the treatment of asthma or hay fever. The best results can only be obtained after experience, good judgment in the selection of cases to be treated, the employment of the correct concentration, and the proper number and time of treatments according to the individual case. Chlorine gas should be administered by physicians only.

Three papers treated of chlorine in the organic chemical industry. In the first one, Dr. J. T. Conroy, chief chemist of the United Alkali Works, Widnes, England, showed how by the aid of elemental chlorine the aromatic hydrocarbons can be made to yield products which are indispensable intermediates in the economical manufacture of dyes and drugs. In the discussion Secretary Fink presented a communication received from Prof. Max Bodenstein of Berlin covering a research with his assistant Dr. Paul Guenther on the heat of formation of CCl_4. It was found to be 25,670 $\pm$300 calories on the basis of the reaction: $CCl_4 + 2H_2 = C + 4HCl + 62{,}330$ cal.

Dr. S. Ochi of Japan has been experimenting on the use of chlorine in the refining of sugar. He told how he had found that chlorine has an efficient action in precipitating the suspended matters in cane juice, and this reaction occurs at a pH value of 3.5 to 4.0 for the chlorinated juice. At the same time gums and pectins separate out with the suspended matter. The bleaching action of chlorine on the syrup of raw sugar is effective up to 80 to 90 per cent of the original color depth. A bleaching beyond 95 per cent is almost impossible in a short time. The syrup which contains free chlorine, even once neutralized, turns alkaline, and is colored dark in the course of the evaporation. The use of activated charcoal subsequent to the chlorination, instead of chlorination only, saves a portion of the chlorine, and a complete bleaching and neutralization can thus be obtained.

Dr. Louis Burgess, chemist of the Standard Oil Co., Elizabeth, N. J., called attention to the application of chlorine in the petroleum industry. It is used in sweetening distillates, and in the production of ethylene glycol and chloro derivatives of methane. Aluminum chloride is employed in the production of gasoline in one of the cracking processes.

Paul S. Brallier, chief chemist of the Niagara Smelting Corporation, described processes for preparing chlorides of silicon, titanium, tin, antimony, zinc and aluminum by the treatment of the corresponding metal, or, in the case of silicon and titanium, the metal carbide, with chlorine. All the metals named react readily with chlorine at certain temperatures; and these reaction temperatures vary from 100 deg. C. for tin and antimony to 1,000 deg. or over for silicon carbide.

Discussing Mr. Brallier's report, Dr. Oliver W. Storey, metallurgical engineer of the C. F. Burgess Laboratories, Madison, Wis., described his method for the production of zinc chloride (U. S. Pat. 1,314,715). Chlorine is allowed to act on zinc in the presence of water. A large tile tower is used, Cl gas enters at the bottom and passes upwards; water enters at the top of the tower and percolates downwards. Over a half million pounds $ZnCl_2$ have been produced. The solutions average 50 per cent to 60 per cent $ZnCl_2$. Basic salts are neutralized with HCl. Dr. Colin G. Fink referred to the process developed by Edwin W. Hale and himself for obtaining zinc chloride directly from the ore. A salt solution saturated with chlorine and a small quantity of bromine is permitted to act on a mixture of raw or roasted blende.

Charles L. Mantell of Pratt Institute, N. Y., discussed the present methods for the recovery of tin from tin scrap and presented some interesting cost figures.

Plants for recovery of tin from tin plate scrap are fairly simple, but need to be designed with due regard to many important details. The plant cost will vary considerably with size of plant, from $15 to $20 per ton of scrap handled, for a yearly capacity of 1,500 tons to as low as $8 to $10 per ton of scrap handled in a plant taking care of 10,000 tons per year.

The final paper of the chlorine symposium was that of William J. Orchard, engineer of Wallace & Tiernan Co., Newark, N. J., who addressed the large gathering of chemists and engineers at an informal dinner at the Chicago Beach Hotel Thursday evening. His subject, "Chlorine in Sanitation," was illustrated with a series of fifty odd lantern slides.

The Round Table Discussions

F. J. Liscomb, engineer of Hanson & Van Winkle Co., was in charge of the electroplating discussion. As there are purposely no records made of these discussions, in order to ensure absolute frankness of opinion, we can merely state briefly the topics discussed. The broad subject was "Selection of the Proper Plating Metals." Among the factors that would decide in favor of one or the other metal, or an alloy of two, are the following: color, resistance to hard wear, resistance to corrosion, high reflective surface, protection during heat treatment, solubility of plate in food acids, building up undersized or worn mechanical parts, and plating for decorative purposes only. Considerable attention centered around the new cadmium and chromium plates.

The second discussion, on electric furnaces, was in charge of W. J. Priestly of the Electrometallurgical Corporation. Electric furnace men and others who have had years of experience with the open hearth and other fuel-fired furnaces were in attendance to discuss and defend the merits of the different types of furnace. A number of the open-hearth advocates claimed that it was not possible to attain the same uniform temperature throughout the metal in the electric arc furnace. On the other hand, temperatures are possible in the electric that cannot be attained in the fuel-fired furnaces. In the case of brass making, the testimony in favor of the electric furnace, arc and induction, was overwhelming. In the heat treatment of steel although the electric installations are rapidly increasing, there are a large number of foundries and steel plants that still prefer the gas furnaces. Nevertheless, as far as reproducibility and uniformity of product are concerned the electrics are much to be preferred.

At the annual business meeting the tellers of election reported that Dr. William Blum, internationally known for his researches on electrodeposition and an active member of the Society for many years, had been elected President. The three new Vice-Presidents are Dr. Paul D. Merica of the International Nickel Co., Prof. Bradley Stoughton of Lehigh University, and Prof. O. P. Watts of the University of Wisconsin. The three new Managers are: William G. Harvey of the American Magnesium Corporation, Dr. B. D. Saklatwalla, Vanadium Corporation of America, and George B. Hogaboom, Hanson & Van Winkle Co., Newark. Acheson Smith, Acheson Graphite Co., was re-elected Treasurer and Dr. Colin G. Fink, Columbia University, New York, was re-elected Secretary.

In recognition of outstanding services and meritorious accomplishments as electrochemist and engineer Dr. Edward Weston was unanimously elected an honorary member of the Society.

Saturday morning's session on Electrodeposition was held at the Kent Chemical Laboratory, Chicago University. H. C. Kremers of the University of Illinois, together with A. P. Thompson (General Chemical Co.) and W. B. Holton outlined their method developed for the preparation of pure yttrium metal. The metal is highly crystalline, is brittle, shows a bright fracture and tarnishes only slowly; it is acted upon by hot water and acids; at elevated temperatures it becomes a vigorous reducing agent; kindling temperature in air is 470 deg. C., in O_2 is 400 deg. C., in Cl_2 is 200 deg. C.; specific gravity 4.57 at 15 deg. C.; the metal is not pyrophoric; its alloys with iron are brittle and resistant to acids.

Dr. Thomas Halstead and Dr. Donald P. Smith received high commendation for their research on the aluminum-magnesium alloys (32 to 48 per cent Mg). A very ingenious melting and casting apparatus was developed to eliminate all possible chances of oxidation and contamination during the preparation of the alloys. Consequently, their results differ from those of previous investigators.

"A General Method for Calculating the Properties of Three-Phase Y-Connected Arc Systems" was the title of the paper presented by A. E. R. Westman of the Engineering Experiment Station, University of Illinois. It was discussed at length by James Kelleher of the Fitzgerald Laboratories, Niagara Falls, President Becket and Dr. William Blum of the Bureau of Standards. The final paper of the Friday morning session was by Dr. T. Fujihara, a student of Professor Saveur of Harvard, on the "Nature of the Protective Film of Iron." Dr. Ulick R. Evans of Cambridge, England, well known for his researches on corrosion, submitted, through the Secretary, a detailed discussion, taking exception to the conclusions drawn by Doctor Fujihara. Others who participated in the discussion were Dr. William M. Corse of Washington, Doctor Fink and Doctor Blum.

The paper by F. F. Colcord, vice-president of the U. S. Lead Refinery, described the parting plant his company has recently completed and which is most modern throughout. After extended discussion there followed two papers by Dr. P. K. Frölich of M. I. T., the first on "Electrochemical and X-Ray Studies of Electrolytic Lead" and the second on "The Electrodeposition of Zinc from Electrolytes Containing Gelatin and Aluminum Sulfate." Dr. H. E. Haring of the Bureau of Standards described a method for measuring polarization and resistivity. Henry C. Parker and Willard N. Greer of Leeds & Northrup Co., pointed out the advantages of the quinhydrone electrode for hydrogen ion control of nickel plating solutions, and Dr. Henry S. Rawdon of the Bureau of Standards described an interesting set of experiments on the protection of iron by cadmium. All of the papers were well discussed. George Hogaboom who presided during most of the session kept the interest alive by challenging various authorities in the particular field.

In closing the Chicago meeting President Becket called upon Doctor Schluederberg of the Westinghouse company who in well-chosen words extended the thanks and appreciation of the Society to the many local members and industries responsible for the unusual success and enjoyment of the convention.

CARL HERING

In Memoriam

CARL HERING, pioneer leader in electrochemical activities, for forty years a prominent consulting engineer in Philadelphia, a scientist of signal achievement, an author, editor and distinguished contributor to technical literature, died suddenly in Philadelphia, on Monday, May 10. On the preceding Saturday he had retired to the Hahnemann Hospital to receive treatment for what he believed to be a minor affection of his heart. He appeared to have had a rapid recovery and was on the point of chatting over the telephone with a friend, when he was struck down with the fatal attack.

His death, at the age of 66, came as a distinct shock to his many professional associates for he was in the midst of customary participation in a number of activities having to do with technical and scientific matters. Only the recent meeting of the International Electro-technical Commission in New York had prevented his attendance at the Chicago convention of the American Electrochemical Society, where, as usual, he was scheduled to play an important part in that Society's affairs. Since 1901, when he with two associates, E. F. Roeber and C. J. Reed, founded the American Electrochemical Society, he had missed but four of its 49 meetings and had served in its principal offices and received every honor that that organization could bestow upon him.

CARL HERING

At the funeral, held at 1820 Chestnut St., Philadelphia, on May 13, many prominent chemists and engineers assembled in respect to the passing of a great leader. On this occasion Pedro G. Salom, one of Doctor Hering's early associates, Carl G. Schluederberg and Harlan S. Miner, officially represented the Electrochemical Society.

Born in Philadelphia March 29, 1860, the son of Dr. Constantine Hering, a noted physician, Carl Hering was educated in the schools of that city and was graduated in mechanical engineering from the University of Pennsylvania in 1860. Later he began the study of electrical engineering, then in its infancy, and this study took him to Darmstadt, Germany, where he worked under Professor Kittler until 1885, when he was appointed chief electrical engineer for a German manufacturer of dynamos and motors. After a year in this work, however, he returned to the United States establishing his office as a consulting engineer in Philadelphia in 1886. In 1887 he was given the professional degree of M.E. by the University of Pennsylvania, which twenty-five years later conferred upon him an honorary doctorate in science. One of the unusual fields of public service in which Doctor Hering was a willing worker was in connection with the various national and international expositions. No less than 11 times he served as a member of or as a prominent officer in the jury of awards or commission of experts at exhibitions in this country and abroad. In 1892 he was appointed technical editor of *Electrical World*, founding and for many years conducting the "Digest of Current Electrical Literature" that has since been a prominent feature of the magazine.

In 1902, a few months after the American Electrochemical Society had been successfully launched, Doctor Hering brought together a small group of enthusiastic chemists who assembled in Philadelphia to discuss the need of a publication devoted to the electrochemical industries—a step that Doctor Hering had long urged. As the outcome of this meeting, W. D. Weaver, then editor of *Electrical World*, interested James H. McGraw in this project and as a result there was founded *Electrochemical Industry*, the forerunner of *Chemical and Metallurgical Engineering*. Dr. E. F. Roeber, then an associate of Doctor Hering, was appointed as its first editor. The late Professor J. W. Richards was the first president of the publishing company and with Doctor Hering served to guide the new publication through its early years of development. Doctor Hering's interest in *Chem. & Met.* was continuous; he was a faithful advisor and a distinguished contributor.

To review the long and fruitful career of Carl Hering requires a broader perspective than that of a single individual or even of a profession, for his life touches upon activities in distant fields. To the electrochemist and engineer he stands as a pioneer, noted perhaps most for his work with the electric furnace that led in 1916 to his discovery of a new electromagnetic force—the "pinch" effect—that tends to contract a conductor through which current is flowing even to the extent of rupture when it is a fluid. This discovery was practically applied in producing an electric furnace now in wide commercial use. As a member of the board of directors of the A. E. S. since its founding, Doctor Hering in 1906 was elevated to the presidency and in 1922 was elected Honorary Member, a distinction that has fallen to but three others in the electrochemical profession.

Cost Analysis in Chemical Production

Comparison of cost data on large-scale waste acid recovery and explosives manufacture

By Chaplin Tyler
Assistant Editor, *Chem. & Met.*

EDITOR'S NOTE: *The following article is continued from one by the same title which appeared on pp. 204-209 of the April issue. Reference to the introductory paragraphs on p. 204 is suggested for a better understanding of the cost analyses presented herewith.*

WASTE, or spent acid is obtained in large quantities from the nitration of organic compounds such as cellulose, glycerine, toluol and phenol. The nitric acid content of such waste acid is recovered either by simple distillation as is practiced in nitrocellulose manufacture, or by distilling in counter-current in a packed column, heat being supplied either by steam or from a mixture of air and steam. The nitric acid and nitrogen oxides are stripped from the descending waste acid; the latter being oxidized and absorbed to make weak nitric acid. Sulphuric acid flows from the base of the tower, and this usually is concentrated further for use in the nitration cycle. High recoveries of both acids are possible. For example, at plant QY, 10,245.1 tons of waste acid containing 3.7 per cent HNO_3 was charged in one month, the average nitric acid recovery being 89.8 per cent. Much higher recovery, up to 98 per cent, has been recorded. Sulphuric acid recovery is practically complete, that is, more than 99 per cent in a properly operated system.

As the costs of distilling or denitrating waste acid ranged from $2.58 per ton at plant QY to $7.39 per ton at plant CH, recovery usually is a paying operation, and in addition, atmospheric pollution by obnoxious nitrous fumes is prevented.

Comparison of operating expenses indicates the importance of careful management. For example, the maintenance charge at plant CH was $4.26 as compared with $0.60 at plant QY. Unquestionably an investigation at plant CH would point to decreased maintenance expense, even as the efficiency was increased from 29.0 to 90.4 per cent in one year.

Table 7—Denitration of Waste Acid
Comparative costs per ton of denitrating waste acid in 6 plants for one month. Loss of H_2SO_4 is charged at $18 per ton and HNO_3 at $135 per ton

Plant.....	CH	OY	PH	LD	QY	PY
General.....	$0.69	$0.27	$0.43	$0.48	$0.27	$0.18
Maintenance...	4.26	1.04	0.88	1.54	0.60	1.02
Power.....	0.72	0.41	0.27	0.31	0.61	0.53
Labor.....	0.78	0.35	1.01	0.62	0.18	0.28
Sulphuric acid lost.....	....	....	0.18	0.38	0.25	....
Nitric acid lost	0.94	1.89	1.63	0.67	0.67	1.31
Total.....	$7.39	$3.96	$4.40	$4.00	$2.58	$3.32
Waste acid charged for period, tons.	713.6	7,500.0	603.0	1,407.8	10,245.1	2,486.9
Ave. composition, per cent H_2SO_4.	69.2	74.2	68.5	70.0	72.3	70.7
Ave. composition, per cent HNO_3..	5.0	5.5	5.8	3.6	3.7	4.1
Efficiency, per cent HNO_3 recovered...	90.4	80.6	84.4	90.1	89.8	81.7

Labor is another item that shows wide variation, being $1.01 at plant PH, and $0.18 at plant QY. This difference is explained in part by the relative quantities of acid charged, but beyond a certain minimum plant capacity, the labor charge per ton of product should be of the same order of magnitude in all plants.

Costs for denitrating waste acid in 6 plants for a period of one month are shown in Fig. 7 and Table 7. Loss of H_2SO_4 is charged at $18 per ton, and of HNO_3 at $135 per ton. Obviously the costs for denitrating are not strictly comparable, as the composition of the waste acid charged varied considerably, being for ex-

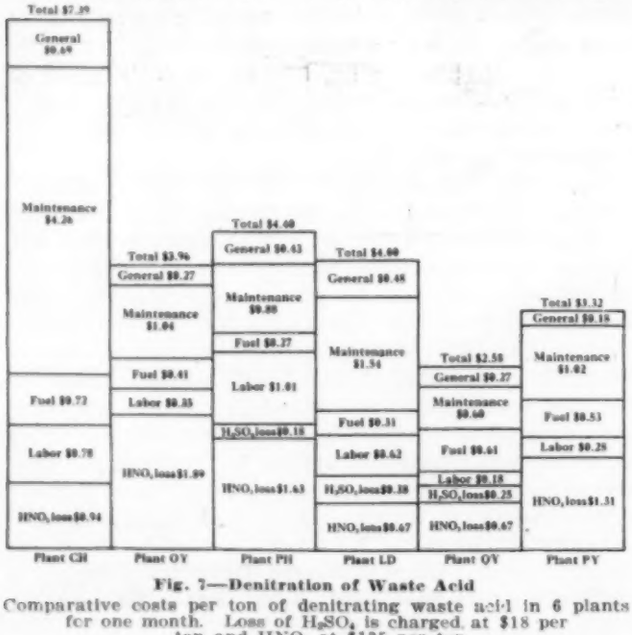


Fig. 7—Denitration of Waste Acid
Comparative costs per ton of denitrating waste acid in 6 plants for one month. Loss of H_2SO_4 is charged at $18 per ton and HNO_3 at $135 per ton

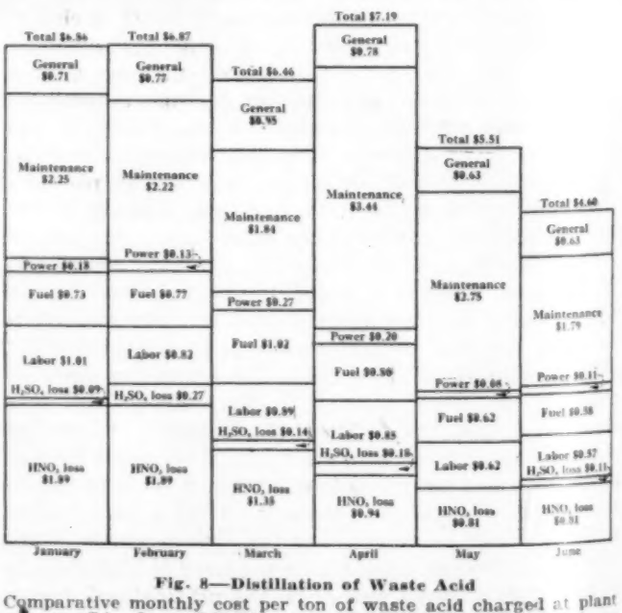


Fig. 8—Distillation of Waste Acid
Comparative monthly cost per ton of waste acid charged at plant GA. Loss of H_2SO_4 is charged at $18 per ton and HNO_3 at $135 per ton

ample 3.6 per cent HNO_3 at plant LD, and 5.8 per cent HNO_3 at plant PH. However, it would be fair to compare plants CH, OY and CH in one group, and plant LD, QY and PY in a second group, as within these groups the composition of waste acid charged is of the same order of magnitude.

Inspection of Fig. 7 shows that the important expense items are maintenance and HNO_3 loss. Thus efficiency, as measured by the per cent of HNO_3 recovered, is of great interest and unquestionably there is too much spread between the high figures of 90.4 per cent at plant CH, and the low of 80.6 at plant OY. Low efficiency is particularly serious when the nitrogen content of waste acid is high, and the opportunities for savings at plants OY, PH and PY are plainly evident. Efficiencies of 97 to 98 per cent have been recorded under favorable conditions, and in plant PY a recovery of 94.5 per cent was made over a 6-month period, when operating on nitroglycerine waste acid. At the same plant and under similar conditions, 90.4 per cent recovery was obtained with trinitrotoluol waste acid, and these figures probably represent a reasonable maximum of performance. A recovery as low as 29.0 per cent was recorded in plant CH prior to effort toward improved operation, and this gives some idea of the possibilities of cutting costs in large-scale operation.

Table 8—Distillation of Waste Acid

Comparative monthly cost per ton of waste acid charged. Loss of H_2SO_4 is charged at $18 per ton and HNO_3 at $135 per ton. Plant GA.

Period.....	January	February	March	April	May	June
General.....	$0.71	$0.77	$0.95	$0.78	$0.63	$0.63
Maintenance...	2.25	2.22	1.84	3.44	2.75	1.79
Power.....	0.18	0.13	0.27	0.20	0.08	0.11
Fuel.....	0.73	0.77	1.02	0.80	0.62	0.58
Labor.....	1.01	0.82	0.89	0.85	0.62	0.57
Sulphuric acid loss.....	0.09	0.27	0.14	0.18	....	0.11
Nitric acid loss	1.89	1.89	1.35	0.94	0.81	0.81
Total.....	$6.86	$6.87	$6.46	$7.19	$5.51	$4.60
Waste acid charged,tons	2,953.8	5,223.3	3,761.6	4,133.6	7,345.4	6,840.5
Efficiency, per cent HNO_3 recovered....	94.3	94.2	96.2	97.2	97.3	97.4

In Fig. 8 and Table 8 are shown comparative monthly costs per ton of waste acid charged over a period from January to June in plant GA. Loss of H_2SO_4 is charged at $18 per ton and of HNO_3 at $135 per ton. The waste acid is principally weak spent acid from nitrocellulose manufacture, and had an average approximate composition of 61 per cent H_2SO_4, 20 per cent HNO_3 and 19 per cent H_2O.

The outstanding feature of operation at plant GA was the remarkable decrease in operating expenses from a level of $6.86 in January to $4.60 in June. Analysis of various items shows that a progressive decrease in HNO_3 loss was the biggest factor. General expense, fuel and labor costs have been fairly uniform with a definite lower trend. Maintenance rose to a maximum in April, but fell off markedly in June and there would seem to be possibilities for a further decrease in this item. Recovery of HNO_3 was excellent throughout the period, ranging from a low of 94.2 per cent in February to 97.4 in June. With a waste acid carrying an average of 20 per cent HNO_3, high recovery should be the first aim of the operator, and the result of such persistent efforts in plant GA is reflected in the cost figures. Improved operation of this sort is the principal object of cost accounting.

Table 9—Picric Acid Production

Comparative monthly costs per ton of picric acid. Phenol is charged at $500 per ton, H_2SO_4 at $18 per ton and $NaNO_3$ at $60 per ton

Period.....	January	February	March	April	May	June
General.....	$67.76	$50.25	$49.81	$48.30	$34.61	$42.70
Maintenance...	17.83	10.44	18.26	20.71	13.03	19.24
Power.....	23.85	17.60	20.09	17.36	10.63	13.05
Labor.....	66.00	57.80	57.00	56.75	45.75	48.80
Packing.....	17.44	11.00	17.66	10.80	4.54	4.38
Fuel.....	8.66	8.98	9.46	8.37	6.88	7.25
Sulphuric acid.	46.80	41.00	39.70	38.68	37.60	36.30
Sodium nitrate	131.40	122.70	119.50	118.10	115.00	114.10
Phenol.....	278.20	272.80	272.90	269.20	266.00	266.00
Total.....	$657.94	$592.57	$604.38	$588.27	$534.04	$551.82
Output for period, tons.	129.1	218.3	198.2	187.1	288.1	205.4
Yield on phenol, per cent....	178.5	183.1	183.5	185.9	187.9	187.9

Picric Acid Production

In making picric acid, melted phenol is sulphonated with strong sulphuric acid at about 100 deg. C. A 50 per cent aqueous solution of the sulphonate is then nitrated with strong nitric acid at about 110 deg. C. the nitro groups substituting the sulphonic groups, making the net reaction $C_6H_5OH + 3HNO_3 = C_6H_2(NO_2)_3 + 3H_2O$.

In Fig. 9 and Table 9 are given comparative monthly costs per ton of picric acid over a period of 6 months in plant GD. Phenol is charged at $500 per ton, H_2SO_4 at $18 per ton and $NaNO_3$ at $60 per ton. A small credit is allowed for sale of waste picric acid. The total cost of production includes that of intermediate phenol sulphonic acid and nitric acid manufacture.

Generally, the graph shows a satisfactory trend in operating economy. There has been a progressive increase in yield, from 178.5 per cent in January to 187.9 per cent in June. This yield figure is of the greatest significance, as the raw material cost, especially that

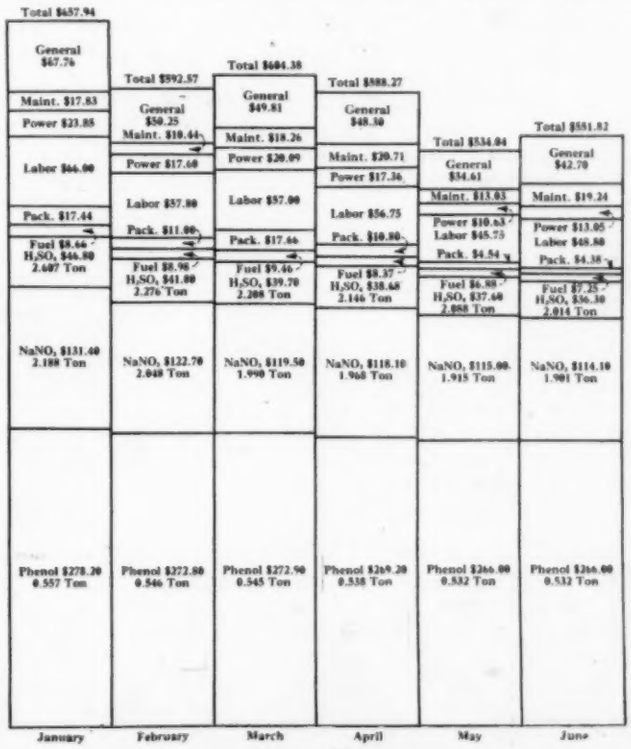


Fig. 9—Picric Acid Production

Comparative monthly costs per ton of picric acid. Phenol is charged at $500 per ton, sulphuric acid at $18 per ton and $NaNO_3$ at $60 per ton

of phenol, is unusually high. Whereas the total raw material cost for January was $456.40, it declined to $416.40 in June, a saving of $40 per ton of product. At the same time operating expense declined also, from $201.54 to $135.42, a further saving of $66.12. A glance at the graph shows, however, that increased operating economy over the period was due primarily to increased total factory output. In January, the month of maximum cost, the output was 129.1 tons, and in May, the month of minimum cost, the output was 288.1 tons.

Raw material economy as pointed out above, increased steadily, phenol ranging from 0.77 ton in January to 0.532 ton in June; sodium nitrate from 2.188 tons in January to 1.901 tons in June; and sulphuric acid from 2.607 tons in January to 2.014 tons in June. This is an excellent record, and shows the possibilities of continued effort to conserve material. Likewise operating expense has decreased markedly, but there is evidence of unsteadiness from month to month, caused probably by fluctuations in output. Unquestionably the operating record in this plant is unusually good, reflecting credit on its managers.

Tetryl Production

Tetryl, or trinitrophenylmethylnitramine, is the product formed when dimethylaniline is nitrated with mixed acid. The formula of tetryl is $C_6H_2(NO_2)_3N(NO_2)CH_3$.

Fig. 10 and Table 10 show comparative monthly costs per ton of crude tetryl at plant QY. Dimethylaniline is charged at $700 per ton, H_2SO_4 at $18 per ton and HNO_3 at $135. High raw material costs plus high operating charges make tetryl the most expensive product considered in this group. Economy of raw materials then, is of unusual importance in this process.

Unfortunately, the quantity of dimethylaniline used per ton of product has increased progressively, being 0.532 ton in January, and 0.553 ton in June. Furthermore this was in the face of rising production, which increased from 9.62 tons to 38.03 tons in January and June respectively. There seems to be no reason why

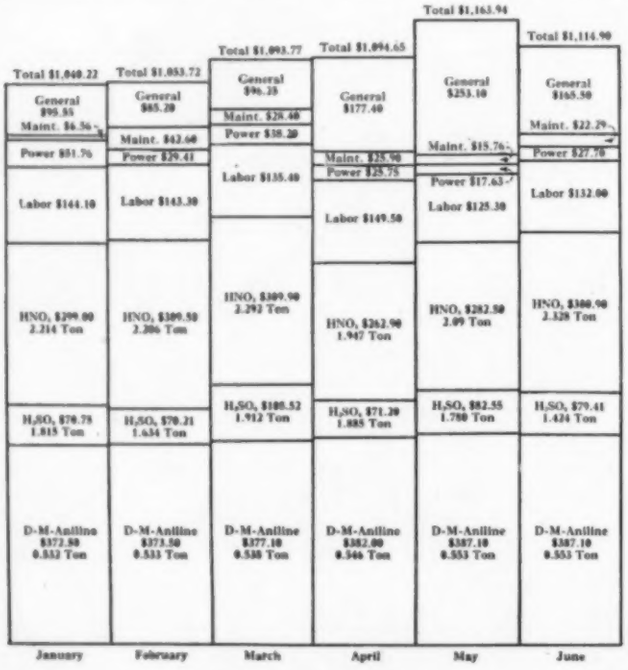


Fig. 10—Tetryl Production
Comparative monthly costs per ton of tetryl. Dimethyl-aniline is charged at $700 per ton, H_2SO_4 at $18 per ton and HNO_3 at $135 per ton

Table 10—Tetryl Production

Comparative monthly costs per ton of tetryl. Dimethylaniline is charged at $700 per ton, H_2SO_4 at $18 per ton and HNO_3 at $135 per ton

Period.....	January	February	March	April	May	June
General.....	$95.55	$85.20	$96.25	$177.40	$253.10	$165.50
Maintenance...	6.56	42.60	28.40	25.90	15.76	22.29
Power.....	51.76	29.41	38.20	25.75	17.63	27.70
Labor.....	144.10	143.30	135.40	149.50	125.30	132.00
Nitric acid....	299.00	309.50	309.90	262.90	282.50	300.90
Sulphuric acid.	70.75	70.21	108.52	71.20	82.55	79.41
Dimethyl-aniline.....	372.50	373.50	377.10	382.00	387.10	387.10
Total.....	$1,040.22	$1,053.72	$1,093.77	$1,094.65	$1,163.94	$1,114.90
Output for period, tons.	9.62	18.67	21.79	22.15	35.30	38.03

the dimethylaniline consumption should have increased; in fact, a decrease would be expected. Under the conditions of operation, the cost of H_2SO_4 was erratic and on the average high, due partly to extensive alterations on the concentration plant. The greatest variation was from 1,912 tons in February to 1.424 tons in June, and undoubtedly economies can be effected in sulphuric acid. Nitric acid consumption likewise shows considerable variation, from 1.947 tons in April to 2.328 tons in June. The low consumption for both April and May suggests the possibility of continually keeping this figure low, resulting in appreciable saving.

Operating expenses, particularly general expense and labor, are at an inordinately high level. The plant is a small one, thus accounting for the fluctuations, but an operating expense of $411.79 per ton during May as compared with $297.97, seems unreasonable. On the whole, the production control at plant QY was unsatisfactory.

Calcium Nitrate Production

In the calcium nitrate conversion process, aqueous calcium chloride solution was available at no cost, consequently the nitrate was made by the double decomposition of sodium nitrate and the calcium chloride, according to the equation $2NaNO_3 + CaCl_2 = Ca(NO_3)_2 + 2NaCl$. The nitrate crystallizes out as the tetrahydrate.

Fig. 11 and Table 11 show comparative monthly costs per ton of calcium nitrate tetrahydrate at plant VA. Sodium nitrate is charged at $60 per ton, and 9 per cent $CaCl_2$ solution is delivered free. The tetrahydrate contains 68 per cent of calcium nitrate. The total cost of production comprises the cost of concentrating the calcium chloride liquor which is supplied at about 9 per cent strength, and the cost of producing from the concentrated liquor calcium nitrate tetrahydrate by interaction with sodium nitrate in accordance with the above equation.

No allowance is made either for the sale of bags, or for the sodium nitrate content of the bags sold, as practice varies in different plants with respect to the washing and disposal of the bags. Normally, there is a credit of from 25 to 50 cents for waste sodium chloride which results from the process, but as this cannot always be sold, it has been disregarded.

Inspection of Fig. 11 shows that total costs have remained fairly steady until June, the end of the 6-month period. The direct contributory causes of high costs for that month were (1) an increased general expense, and (2) an increase in labor costs. This sudden rise in total production costs from $72.18 per ton in May to $78.86 per ton in June, is traceable to a

marked decline in output, from 5,169.0 tons in May to 2,819.2 tons in June. Obviously, general expense and supervision would remain substantially constant regardless of output.

During the latter part of the period it was found that certain errors had been made in estimating the intermediate stocks of sodium nitrate in process, and this is reflected in the very low figure of 0.713 tons per ton of product consumed during May. The high average consumption of 0.753 ton for the 6-month period is due largely to the high recorded consumption during the months of January and February.

With the exception of May and June, during which months production was heavily curtailed, operating expenses have remained fairly uniform. At this plant cooling water was pumped nearly a mile, hence the item of power increased with the coming of warmer weather. Maintenance, it will be noted, is comparatively unimportant in calcium nitrate manufacture, ranging from 2.5 to 4.6 per cent of the total manufacturing cost. Labor costs have been somewhat erratic from month to month, and the only explanation is in the difficulty of adjusting closely the direct labor payroll to meet the fluctuations in output which are indicated in Table 11.

Analysis of the monthly costs of production, as shown by Fig. 11, indicates the variations to be expected under favorable operating conditions and with wide fluctuations in output.

Table 11—Calcium Nitrate Production

Comparative monthly costs per ton of calcium nitrate tetrahydrate at plant VA. $NaNO_3$ is charged at $60 per ton and 9 per cent $CaCl_2$ solution is delivered free

Period	January	February	March	April	May	June
General	$2.56	$2.68	$2.66	$3.56	$0.91	$6.35
Maintenance	2.40	1.84	2.79	2.35	3.36	2.84
Power	0.33	0.32	0.36	0.46	0.56	0.79
Fuel	8.35	10.85	11.59	8.45	10.42	10.22
Labor	9.83	11.00	12.26	10.00	14.13	15.00
Sodium nitrate	47.70	45.60	45.00	44.20	42.80	43.76
Total	$71.17	$72.29	$74.66	$69.02	$72.18	$78.86
Output for period, tons	8,560.8	9,281.0	7,991.2	6,266.8	5,169.0	2,819.2

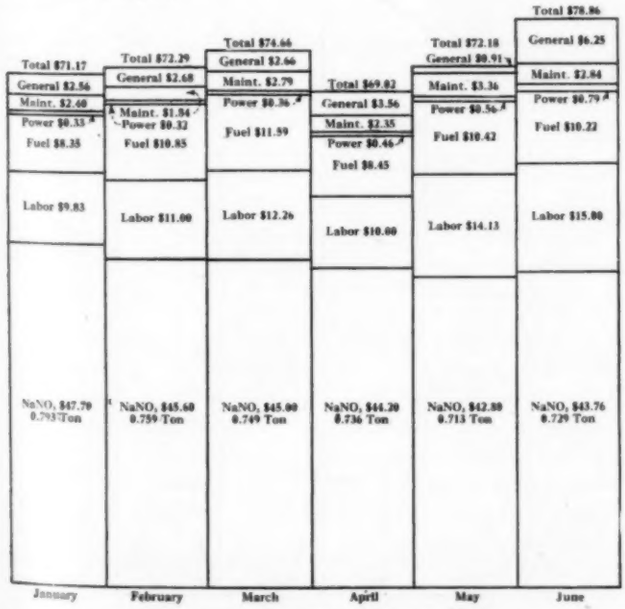


Fig. 11—Calcium Nitrate Production

Comparative monthly costs per ton of calcium nitrate tetrahydrate at plant VA. $NaNO_3$ is charged at $60 per ton and 9 per cent $CaCl_2$ solution is delivered free

Table 12—Ammonium Nitrate Production

Comparative costs per ton of ammonium nitrate by the calcium nitrate conversion process and ammonia-soda process, for a 2-month period. NH_3 is charged at $250 per ton, $NaNO_3$ at $60 per ton and 68 per cent $Ca(NO_3)_2$ at $73 per ton

Plant	LK		LK		SN	
Process	Calcium Nitrate		Ammonia-Soda			
Period	May	June	May	June	May	Jun
General	$1.77	$2.11	$1.77	$2.11	$12.40	$12.16
Maintenance	4.54	4.01	4.54	4.01	7.92	7.03
Power	8.35	9.12	8.35	9.12	3.23	2.84
Fuel	....	....	....	....	6.06	6.93
Labor	9.60	10.82	9.60	10.82	13.71	12.10
Packing	2.48	2.23	2.48	2.23	....	....
Ammonia	59.00	57.50	59.00	57.50	58.50	57.25
Carbon dioxide	0.92	0.96	0.92	0.96	....	....
Calcium nitrate	113.90	112.00	....	....	....	....
Sodium nitrate	.....	.....	65.80	65.20	71.25	67.80
Total	$200.56	$198.75	$152.46	$151.95	$173.07	$166.11
Output for period, tons	4,386.8	2,531.0	2,312.8	1,840.7	2,116.8	1,977.0

Ammonium Nitrate Production

Ammonium nitrate was prepared by two different processes, (1) the calcium nitrate conversion process, and (2) the ammonia-soda process. In the former method, the reaction is, $(NH_4)_2SO_4 + Ca(NO_3)_2 = 2NH_4NO_3 + CaSO_4$, the separation of products being dependent on the formation of insoluble calcium sulphate. In the latter method, sodium nitrate reacts with ammonia and carbon dioxide in aqueous solution, $NaNO_3 + NH_3 + CO_2 + H_2O = NH_4NO_3 + NaHCO_3$. Crude sodium bicarbonate is a byproduct of the process.

Fig. 12 and Table 12 show comparative costs per ton of ammonium nitrate manufacture by the calcium ni-

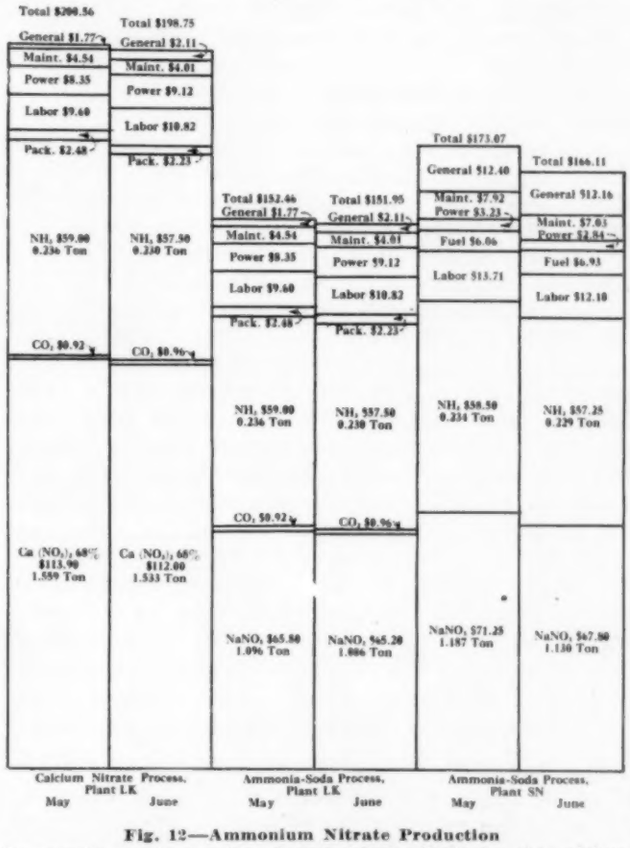


Fig. 12—Ammonium Nitrate Production

Comparative costs per ton of ammonium nitrate by the calcium nitrate conversion process and ammonia-soda process, for a 2-month period. NH_3 is charged at $250 per ton, $NaNO_3$ at $60 per ton, and 68 per cent $Ca(NO_3)_2$ at $78 per ton

trate conversion process and the ammonia-soda process for a 2-month period. In plant LK both processes were used, and in plant SN the ammonia-soda process only was used. Ammonia as NH_3 is charged at $250 per ton, $NaNO_3$ at $60 per ton, and 68 per cent $Ca(NO_3)_2$ at $73 per ton. Carbon dioxide gas was supplied to the process practically free, being charged at $2 per ton. In the ammonia-soda process there is a small credit for the crude bicarbonate.

At plant LK no allowance is made for $NaNO_3$ losses either in bags or in handling, as periodic inventories showed a slight excess at all times. However, at plant SN an allowance of 2 per cent has been made for such losses.

At plant LK ammonium nitrate was produced by two processes—the calcium nitrate conversion process and the ammonia-soda process. As the cost records at plant LK do not provide separate operating expense accounts for the two processes, the total has been apportioned equally per ton of product. This assumption is probably incorrect as it throws too much burden on the ammonia-soda process.

Furthermore, general expense at this plant does not include administrative salaries, and no notice has been taken of sodium nitrate refining costs, which increases the cost of that material about $15 when it is used in the ammonia-soda process. It is regrettable that the foregoing factors are not reflected fully in the cost sheets, but nevertheless the information given is undoubtedly of considerable value. At least the cost indicates the considerable differential, about $48 per ton, between the two processes as operated in the same plant. As the production at plant LK using the calcium nitrate conversion process was 6,917.8 tons of ammonium nitrate during the period May to June, the probable saving by using the ammonia-soda process would have been $332,000.

Comparing sodium nitrate consumption in the two plants, it will be noted that better apparent economy was effected in plant LK. Actually, however, this advantage is not wholly real, as the nitrate used in plant LK was refined carefully, and the weight of the impure salt was not recorded. Regarding the relative nitrate consumption in the two processes, there is practically no difference in chemical efficiency when calcium nitrate tetrahydrate and sodium nitrate consumption is calculated on an equivalent basis. This comparison can be calculated upon the quantity of sodium nitrate required to produce 1.58 tons of calcium nitrate tetrahydrate, the weight required to produce 1 ton of final product. Ammonia consumption in the two plants and by both processes is nearly constant, varying from 0.229 ton to 0.236 ton. Sodium nitrate consumption can probably be improved, however.

Operating expenses at plant LK are much lower than for plant SN, due to lower general expense, maintenance and labor. The considerable excess of general expense and maintenance at plant SN is due partly to reduced output, which results in an increase in charges per unit of product.

Ammonium Perchlorate Production

The electrolytic formation of ammonium perchlorate is an oxidation process which takes place when the decomposition products are allowed to mix at elevated temperature and in the presence of high chlorate concentration. Consumption of electric energy is normally a factor most carefully to be watched.

Table 13—Ammonium Perchlorate Production

Comparative monthly costs per ton of electrolytic ammonium perchlorate. $(NH_4)_2SO_4$ is charged at $70 per ton

Period.....	February	March	April	May	June	July
General.....	$174.00	$171.10	$162.15	$192.90	$154.90	$120.00
Maintenance...	120.40	124.60	221.10	192.40	169.60	93.50
Power.....	25.95	21.70	25.60	41.40	19.60	15.90
Electricity....	156.90	131.80	181.60	281.50	176.00	135.00
Labor.....	96.60	86.75	107.10	117.40	97.30	59.00
Misc.chemicals	15.86	11.10	7.10	9.54	11.78	9.42
Ammonium sulphate....	43.80	42.80	44.20	43.80	43.10	42.75
Total.....	$633.51	$589.85	$748.85	$878.94	$672.28	$475.57
Output for period, tons.	134.0	125.0	100.0	75.0	114.8	208.8

Fig. 13 and Table 13 show comparative monthly costs per ton of ammonium perchlorate by the electrolytic process. Ammonium sulphate is charged at $70 per ton, and the cost of other chemicals, mainly sodium chloride, is virtually negligible. This process is notable in that raw material costs are comparatively unimportant, and by the same token the various items of operating expense assume relatively great magnitude. The item of process electricity is normally a controlling one in electrochemical manufacturing costs.

Total costs at this plant are extremely variable, reaching a maximum of $878.94 per ton in May, and decreasing sharply to a minimum of $475.57 per ton in July. Inspection of the monthly tonnage reconciles this variation in part, as the output increased from 75.0 in May to 208.8 in July. However, the energy efficiency of a process should be entirely independent of the output, and this large factor in operation should be fairly constant.

General expenses and maintenance approached a satisfactory level during July, but for the other months these items probably are at too high a level. Royalty payments enter into general expense, and this is a factor in the high figure throughout the period. The present process is an excellent illustration of the possible cost fluctuations in industrial chemical manufacturing, and of the extreme importance of controlling costs according to reasonable standards of performance.

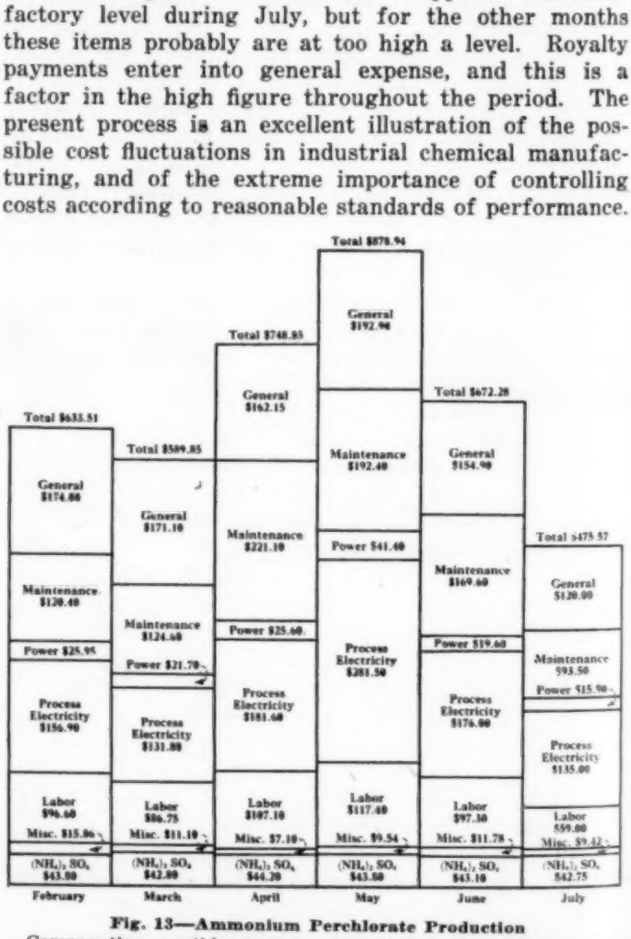


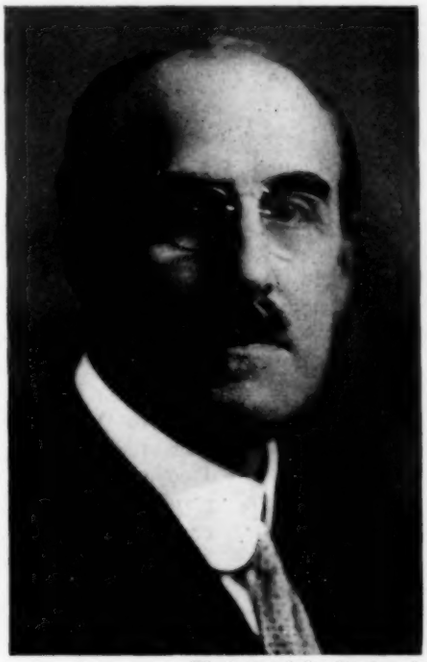
Fig. 13—Ammonium Perchlorate Production

Comparative monthly costs per ton of electrolytic ammonium perchlorate. $(NH_4)_2SO_4$ is charged at $70 per ton

Failure to Make Full Cost Analyses Wastes Technical Efforts

Presidential address of Frederick M. Becket before the American Electrochemical Society Chicago, April 23, 1926

FOR the past twenty years it has been my privilege to investigate and appraise the technical and commercial feasibility of processes directed to the manufacture of a wide variety of products. These processes have been presented as commercial possibilities by engineers or experimentalists in many fields and in various stages of development. The faker's case has no bearing on my thesis, and it is fortunate that perception rather than wide experience is required to detect his predatory projects, although it is pitiful that the ingenuity sometimes displayed should not have been exercised in a fruitful direction. The unfortunate cases are those of the honest and conscientious experimentalists who expend much mental effort in attempting and very often accomplishing goals which they believe to be commercially attractive. Still sadder are the cases of the small group, sometimes including the capitalist, who after successful experimental work organize a small company, erect a modest plant and develop the technology of the process, properly desiring to demonstrate at least in a semi-commercial way the feasibility of the whole scheme and believing that at such stage the enterprise will more readily interest capital and return a large profit on the money previously expended.



Photograph by Bachrach
Frederick M. Becket

Now, it is deserving of special emphasis that in a large proportion of the hopeless cases that have come to my attention, the great error, the cause of the wasted effort, has been found either in complete omission of any attempt to estimate the cost of manufacture, or more often to predetermine it with reasonable accuracy. In all of these cases a revealing estimate could have been made by assuming theoretical yields from the chemical reactions and excellent results in connection with all other factors. The last thought is worthy of a little elaboration in that it provides a method of precluding these extremely wasteful procedures. By assuming theoretical yields from the chemical or electrochemical reactions, which are oftentimes interestingly clever, and by further taking the most optimistic view of all other factors that an experienced, reasonably intelligent engineer would dare to assume, it has been possible by cost estimating in this way to convince many who have experimented diligently that they have been seeking a worthless goal. The saddest instances revealed by this method are those in which mental energy and capital have been wasted to a much greater extent, in which the technology of a process has been carried to successful demonstration on a minor scale and for which great economy has been forecast in the operation of a plant of commercial size. In cases of the latter class cost estimates had been prepared by the proponents. Then wherein lies the difficulty? The most serious errors are those of complete omission of important cost factors rather than the application of poor judgment to the factors considered, although frequently both errors are combined.

That a stronger impression may be left of the type of pitfalls that have brought keen disappointment to many sanguine and in some cases obstinate persons, it may be well to depart from broad generalizations and mention a very few specific cases drawn from actual experience. For obvious reasons the citations will avoid identification of processes or persons.

Within the past decade a process for the extraction of potash from an abundant domestic mineral was devised, considerable preliminary work was performed, the technology of the novel steps was developed in semi-commercial apparatus and the process was offered to one of the companies with which I am connected. In common with other processes of the kind the transition from potash-bearing rock to a soluble potash salt offered the major problem, the solution of which presented the chief novelty. Hence most of the money and effort were expended on the design, development and operation of the furnace in which the rock was decomposed at a moderate temperature through ingenious reactions. Good thermal economy and a high recovery of soluble potash were attained and were accepted as criteria of commercial success. The steps subsequent to leaching of the furnaced product, which were principally washing and evaporating operations, fretted the chief technologist and his associates not at all and had never been carried out quantitatively, on the ground that they represented "perfectly simple chemical engineering." Early in our investigation an estimate was made of the cost of operating this complete process, based on the assumption that substantially theoretical yields would result from the furnace reactions, and it brought to light that the cost of evaporating the necessarily dilute solutions even by the most efficient means precluded the commercial success of the project, if the average selling

prices of the potassium salt and the byproducts were duly considered. Neglect to estimate the cost of "perfectly simple chemical engineering" processes explains the failure of this enterprise.

Twenty odd years ago I made a similar though much less costly mistake by carrying somewhat too far experimental work on the electric furnace production of certain aluminates before realizing the relatively great cost of evaporation. This process embraced a combination of chemical reactions of which I was rather proud.

An example of a different class is represented by a high temperature, electrolytic process for the reduction of a metal having a melting point over 1,500 deg. C., which was offered after considerable work had been conducted on a moderate scale. Samples of the product were presented with the claims for predicted commercial success. In this instance, quite apart from glaring practical difficulties that had not been solved and speculation concerning the quality of the product, the estimated cost of the three items raw materials, power and labor, assuming one hundred per cent current (ampere-hour) efficiency and a large scale operation, slightly exceeded the highest selling price of the product over the several years preceding. The market price of this product is today 40 per cent less than at the time of the investigation. Later, this process met with a reception enthusiastic enough to be optioned by another group who continued experimentation for a few months, but it was soon thereafter abandoned.

Some years ago a fairly rich ore became available at a reasonable mining cost, but the expense of transportation to seaboard was prohibitive. The problem was clearly economic, and smelting at the mine, at seaboard and at the market were all visualized, and both electric and fuel heat were considered. But instead of estimating the cost under each of the possible programs, expensive experiments in electric smelting were made with the view of producing metal at the mine, where carbon could be had in limited amount. The intention to transport metal rather than ore was wise, but the cost of developing water power under prevailing conditions was not considered, or at best was carelessly dismissed. Only after prolonged research had given promise of a feasible smelting process did the promoters begin a hydroelectric investigation. The report gave a power cost so excessive that electric smelting could not be undertaken in the neighborhood of the mine. As the electric furnace offered no advantage after transporting the ore, the smelting investigation was completely wasted by allowing it to precede the estimation of cost.

I could continue to cite from my own experience numerous examples, some containing the element of surprise even to a greater degree. There is no need for further reminiscence, but it should be emphasized that this appeal is not influenced by the innumerable projects investigated that have been weighed and found wanting for various other reasons. It is not my purpose to analyze and explain the numerous errors of engineering and financial judgment which are being made continually in attempts to forecast the commercial success of proposed electrochemical undertakings, and I do not wish to pose as an expert in such matters. Such a discussion would involve broad subjects of engineering and economics beyond the intentional limits of this address.

So many examples having come within my own experience, it is reasonable to assume that similar occurrences have been shared by many others—indeed, at least some confirmation of this has been gathered from engineering friends—and therefore I contend that in the aggregate a stupendous waste of technical effort still continues through the performance of experimental work to a substantially useless end, because reasonably accurate cost estimates are not being made to determine the economic accomplishment in the event of technical success. It is fully realized that no systematic work represents a complete loss, but there is little consolation in this thought when one considers the contributions to industry that might have resulted had the same effort been applied more wisely. Especially does this seem true when it is conceded that much of the misspent work to which I have alluded was technically sound and ingenious.

Less emphasis would be laid if useless commercial experimentation had eventual value as research in pure science, a result seldom realized because the motives are usually different. Research in pure science having been mentioned, may I digress slightly from my concrete topic to express approbation of this class of endeavor. Much of the research in pure science has been actuated by a desire for fundamental knowledge and the progress of mankind without regard to financial reward. Love of service and the search for truth have been the impelling forces. Nevertheless there is increasing realization that the search for basic principles has eventually returned the highest financial compensation. But whatever the motive, purely scientific research has given us an increasingly better world in which to live—physically without question, and spiritually let us hope. We surely sympathize with the urgent appeals that have been made publicly of late for a great expansion of the scale upon which research in pure science is being pursued in this country. The latest I have noted is the admirable address delivered last December by Secretary Hoover before the American Society of Mechanical Engineers, and it is my hope that American Electrochemical Society through the support of all the members will assume its full share in promoting pure science research.

The theme so far has been predominantly critical. My desire is not only to ask you to consider more carefully this particular type of wasteful effort, but to offer some constructive suggestions.

A fairly thorough search of the books and technical articles relating to industrial cost accounting and allied subjects has shown the lack of a practical guide adapted to cost estimation of this type. It is acknowledged that there are several excellent books on industrial cost accounting, but so far as I am aware these are all intended primarily to teach systematic methods of cost distribution and of determining total costs in established producing enterprises. Elaborate in details, these books serve the purposes of the cost accountant and the executive rather than the young engineer or experimentalist. Cost accounting has become a specialized business, particularly in our larger manufacturing concerns, but seldom does the practical operating man find opportunity to learn cost-keeping methods, especially those finally applied in the administrative department. Fortunate are the experimentalists who have acquired the combined experience of practical production and cost accounting. Such men are exceptions and theirs is the duty to advance this cause. It was

pleasing to learn very recently that there is in preparation a book by Tyler which will not only discuss the point already stressed, but will contribute prominently to chemical engineering through exposition of other economic aspects.

The following schedule portrays the general lines upon which a cost estimate may be drawn. From this the novice can derive constructive suggestions although some of the initiated may criticize it as obvious and therefore unnecessary. Nevertheless it is presented with confidence in its value, since my own experience has shown that the timely use of even this slight assistance toward approximate cost prediction would have saved a vast amount of work which is known to have been wasted in fore-doomed undertakings.

TYPICAL SCHEDULE FOR COST ESTIMATION
CHEMICAL INDUSTRIES

Producing Costs

- Basic Raw Materials Delivered
- Other Process Materials
- Power: Electrochemical and Mechanical
- Fuel
- Electrodes and Fittings
- Process Tools and Supplies
- Repair Materials: Equipment and Structures
- Packages
- Manufacturing Wages
- Repair Wages: Equipment and Structures
- Works Salaries
- Works General Expense

Management and Marketing

- Salaries
- Rent
- Accounting
- Selling
- Legal Service
- General Expense

Capital Costs

- Amortization
- Depreciation
- Insurance
- Taxes

The principal object of such a schedule is to ensure that no important item of cost shall be forgotten. Naturally each class of process will call for modification of any typical schedule. A mechanical guide of this kind is of great assistance even to the experienced estimator.

Before attempting to predetermine costs it is a logical procedure to select an appropriate scale of operation and then to visualize the complete plant and organization required for the desired end. However clearly a process may have been conceived as a succession of chemical reactions and unit processes, cost estimating each material and operation develops a clearer picture of the producing and economic structures; and the mental courage requisite to develop a thorough cost estimate will find its reward in an enhanced understanding of the project. In every case the estimate deserves careful analysis. An estimate which reflects favorably on the process will show points of strength and of relative weakness, so that further work can be directed toward factors in which further economies should be sought or can most easily be secured. The autopsy on an unfortunate process will usually reveal the principal cause of failure and will at least dictate the need of a new line of attack. If the product is already being made by another method, an estimate of the corresponding cost may wisely be attempted, since however ingenious a new process its competitive utility will be slight if the cost is relatively high. Clearly a cost estimate is the logical nucleus around which to gather data for the complete engineering report which the critical executive desires.

It is not my intention to discuss the details of cost estimation nor to proffer suggestions to the professional cost analyst or proficient engineer, and hence the foregoing schedule is not so branched and twigged as to resemble a chart showing the multitudinous derivatives of coal tar. Such elaboration would be irrelevant; furthermore, whatever value exists in the thoughts here presented lies in the ease of their apprehension which explains the intentional omission in the schedule of the current terms, "direct charges," "indirect charges," "burden" and several others.

To young experimentalists in industrial electrochemistry, to the many older workers who apparently have not yet awakened, I appeal for adoption of the practice of predetermining costs; and I extend my appeal to the skilful members of this Society not only to proclaim the principle, but to render more service through greater assistance to the inexperienced.

The extent of the conservation possible by adoption of this practice is indeterminable, but this does not deter me from expressing the opinion that in this one direction the potential economy of human effort alone represents an appreciable increase in our rate of progress in chemical industry. If financial terms will lend weight to my contention, I can say conservatively from my own knowledge that several millions of dollars, in all probability many millions, have been wasted on experimental projects for the lack of timely cost estimation. This being the case of a single observer, what must the figure be in the aggregate?

Does my theme warrant mention of its relation to the courses in chemical engineering as now organized in our numerous schools of technology? Earnestly I believe it does.

The splendid work of the Society for the Promotion of Engineering Education and the liberality of engineering educators in publishing the conclusions of their teaching experience are matters deserving great credit. Apparently several important questions are still under discussion. For example, experienced men are advocating that cultural subjects be retained or even returned to the engineering courses to the reasonable utmost. Others equally sincere and qualified are urging that the four-year engineering courses be further specialized, or that five or six-year courses be instituted where the inclusion of cultural subjects is also desired. As another example, a marked difference of opinion exists concerning the extent to which thoroughly practical work should be performed by the engineering undergraduate. In the first case, fearful that unless the need for future development of the cultural studies be sown in the younger years, and realizing that many of the ambitious graduates will not sow this seed until too late to reap the desired harvest, I do not suggest curtailment of the time now devoted to cultural studies in the engineering courses, provided the subjects are extremely well chosen. In the other instance, based on my observation of the widely different capabilities of the younger engineering graduates of different types of training, I strongly advocate inclusion of the relatively large amount of practical work now demanded in a very few of our university curricula, in so far as this applies to engineering courses strictly.

In recent years the courses in business administration

have attracted many enterprising students of the engineering type. Observers of this trend assure us that farseeing students have become informed of the shortcomings of engineers in business and have concluded that the collegiate business course offers prospect of larger earnings, both initial and ultimate. Many students have supplemented a course in business administration by one or more subsequent years in engineering, thereby securing an exceptionally useful combination of training with proportionate financial return soon after entering business life.

Engineering work must be done and probably enough men will always be willing to prepare for it. That their material welfare may not be sacrificed in the interest of the profession, their training should be remodeled from time to time through adjustment to the needs of business, which engineering so valuably serves. For many reasons most men can set apart only four years to collegiate training and therefore the period must be devoted very largely to technical instruction together with the pre-requisite sciences. Hence the agreement is general that an engineering course must be essentially technical and that a strong infusion of business subjects would more than defeat its own purpose.

It is highly important that the teacher be capable of bringing to the subject experience, a belief in its utility, and the knack of correlating technology and cost estimation. How best can this subject be taught? Into an already crowded curriculum it appears unwise to urge additional work, but it seems some slight substitution could be made to advantage. A survey of the engineering courses shows that a large majority of these include the study of economics; however, in most cases it is more nearly political economy than commercial economics that is being taught. As a general principle, is it the wiser plan to concentrate collegiate instruction on subjects the student can properly grasp only through capable guidance, or to sacrifice this opportunity in part by including subjects which can well be self-taught by a course of reading in later life? At least in so far as applied economics is concerned, it seems to me the former method should be employed if the undergraduate shall early appreciate the relationship of business to engineering. Specifically I recommend that many of the present courses in economics be modified by diverting time to instruction in cost estimation, including for maximum benefit practical applications to engineering. As a stimulus to analytical thinking, as a means of firmly establishing invaluable impressions, and as a method of testing the mastery of theory, the possibilities of this procedure deserve much wider recognition.

Briefly recapitulating, a vast amount of mental energy has been expended for industrial research and development toward goals devoid of economic profit. Many projects could properly have been rejected at their inception had cost estimates been made under assumed ideal conditions; others on which experimentation was unwisely prolonged could have been abandoned much earlier had reasonably accurate cost predictions been invoked. Therefore, looking toward accelerated progress, as a plan of conservation I appeal to young industrial experimentalists and to their guilty elders to adopt the practice of frequent cost estimation; and to the experienced members of this Society it is enough to mention these opportunities for augmenting their service by more frequent assistance to the uninitiated.

Atomic Hydrogen Arc Welding

Tests of welds made on many metals and alloys show good results from this new method

WHEN a stream of hydrogen is directed into an arc between tungsten electrodes a flame of atomic hydrogen is produced that is of even higher temperature than the oxy-acetylene flame. To utilize this flame for welding metals it must be arranged for complete, easy control. Several types of welding torch have been developed that successfully accomplish this purpose. In the preferred type the electrodes between which the arc passes are mounted at a convenient angle to one another and are adjustable so that they can be brought into contact at a point which is exposed to a blast of hydrogen from one or more orifices. Thus the atomic hydrogen is blown out of the arc in a definite direction and forms a flame which can be brought into contact with the metal to be welded. The jet of hydrogen also serves to bathe all the heated parts of the electrodes and the work, thus preventing oxidation and the introduction of impurities into the weld.

In one type of torch the electrodes, consisting of tungsten rods $\frac{1}{8}$ in. in diameter, are held in position at an acute angle to each other by lava insulators. They are kept in contact by a spring when not in use. By applying pressure to a lever mounted on the handle, the tips of these electrodes may be separated as desired up to $\frac{3}{4}$ in. Slow adjustments are made by a setscrew attached to the lever.

The hydrogen is supplied by a tube which passes through the handle and then by flexible tubes is delivered to each of the electrode holders, where it escapes through the annular spaces between the electrodes and the insulators. Sufficient hydrogen is used not only to surround each electrode to the tip but also to form a blast which blows the atomic hydrogen against the work and keeps it bathed in hydrogen.

In another type of torch a jet of hydrogen is directed into the arc from the end of a tube, while a stream of lower pressure hydrogen escapes from openings in a hemispherical disk around the tube and thus surrounds the electrodes and work with a bath of gas.

Some torches, for use with 3-phase currents, have three movable electrodes arranged symmetrically like the three edges of a triangular pyramid. Although the 3-phase arc is of more stability and has other advantages, the increased complication in torch design makes its use generally inadvisable.

Modern standard arc welding equipment is not suitable as a power source for the atomic hydrogen torch because the striking voltage and the arc voltage must be higher. For direct current the arc may be stabilized by a series resistance, which gives good results with a 250-volt line current, or a special constant-current generator may be used.

Alternating current permits the arc to be stabilized by reactance, generally giving greater efficiency. A line voltage of 350 to 400 gives satisfactory operation. Voltages as high as this are only needed to give stability and to enable the arc to be started at any time by separating the electrodes.

To strike an arc by means of the lever mechanism of

Abstracted from article by R. A. Weinman and Irving Langmuir, General Electric Review, March, 1926.

the torch with cold electrodes requires an open circuit a.c. voltage of 320. After the arc is started and the electrode tips reach operating temperature a line voltage of 150 is sufficient to restart the arc as long as the electrodes remain nearly at operating temperature. This lower voltage can be used for starting the arc if special means are taken to heat the electrodes, but it is more convenient to use an open circuit voltage of approximately 400.

The drop across the arc, in normal operation, is about 80 volts. Danger to the operator is avoided by insulating the entire arc circuit from ground. A motor-generator may be used to give either direct or alternating current for the arc, but a specially designed transformer is usually more satisfactory.

When the arc is not operating the electrodes are kept in contact by means of a spring attached to the control lever, so that there are no voltages on them and the torch can be laid down on any material without danger of flashing the operator's eyes. To strike the arc the electrodes are separated by pressing the lever. Should the open circuit voltage at any time be impressed across the electrodes when separated or the operator break the arc by separating the electrodes too far, a relay in the arc circuit will trip the feeder circuit, in which case it is necessary for the electrodes to be brought in contact again before the main feeder circuit can be restored.

The Welding Arc

The torches described operate ordinarily with currents from 20 to 70 amperes depending on the thickness of the work. For greater currents, larger diameter electrodes with special supports are used. The above mentioned currents will handle work from $\frac{1}{8}$ to $\frac{1}{4}$ in. in thickness. The rate of welding on 4 in. lengths is from 15 to 20 ft. per hour. The voltage drop across the arc, 60 to 100 volts, depending on the opening between electrode tips, is nearly independent of the current in the range 20 to 70 amperes. Tests show that the 60 to 80 volt arc obtained with a separation from $\frac{1}{16}$ to $\frac{1}{8}$ in. has a more concentrated working zone and in the most efficient for most kinds of welding.

For ordinary welding 20 to 30 cu.ft. per hour of hydrogen is used, although for outside work, especially in windy places, the amount is increased. The gas pressure required is small, less than 1 lb. per sq.in. being required for welds up to $\frac{1}{4}$ in. thick.

Electrode consumption varies with the depth of penetration of the weld, being less than $\frac{1}{16}$ in. per 24 in. of weld on work $\frac{1}{8}$ in. thick up to $\frac{3}{32}$ in. per inch of joint on work $\frac{1}{4}$ in. thick. This is for alternating current, the consumption being higher for direct current.

With two electrodes, a fan-shaped arc of narrow section and $\frac{3}{8}$ to $\frac{1}{2}$ in. spread is obtained. This arc, with a current of 20 amp. or more, will melt an iron rod $\frac{1}{4}$ in. in diameter when placed 2 in. distant. By bringing the arc closer to the surface of a larger mass of metal, the metal melts more rapidly. For welding the torch is brought so close to the metal that the lower portion of the arc is just in contact with the metal, which causes the arc to change its shape. The tip of the electrodes is then about $\frac{3}{8}$ to $\frac{1}{2}$ in. from the work.

For good welding the torch is inclined at about 45 deg. to the plane of the metal surface so that the blast of hydrogen passes over the pool of molten metal in a direction opposite to that in which the torch is being moved along the weld. In this way the metal at every point becomes heated and melts rapidly, but cools comparatively slowly so that the dissolved gases have time to escape before the metal freezes. The resulting avoidance of gas pockets and inclusions is an important phase of the process. The blast of hydrogen serves to blow away gases that escape from the pool of molten metal, so that they do not disturb the arc, the flame of atomic hydrogen preserving a constant shape so that a uniform weld can be obtained.

Gases Other Than Hydrogen

Mixtures of hydrogen and nitrogen in equal parts gives good welds, as ductile and solid as when pure hydrogen is used. However, this mixture requires an increase in arc voltage of 10 to 20 per cent over that needed for hydrogen alone, when using the same current.

Illuminating gas with graphite electrodes give ductile welds on copper and some other non-ferrous metals, but gives porous welds on steel. When hydrogen is added, up to 75 per cent, ductile welds are obtained on iron and iron alloys. Graphite electrodes with hydrogen alone give non-porous welds on iron. However, these electrodes require an excessive amount of adjustment because of the rapid rate of consumption. Tungsten electrodes with illuminating gas give about the same results as graphite electrodes. Decomposed ammonia gas gives results similar to mixtures of ammonia and nitrogen. Decomposed methane has the disadvantage of attacking the tungsten electrodes, forming tungsten carbide at the contact ends and increasing the arc voltage required approximately 50 per cent.

Most of the experiments were conducted with hydrogen alone. Good welds were made on low carbon steels up to $\frac{1}{4}$ in. thick without additional metal. Full automatic welding without the use of additional metal is successful with this method. On welds with thickness greater than $\frac{1}{4}$ in. filler metal is sometimes necessary. Various alloy filler rods have been used successfully. Aluminum and nickel, alone and together, are successfully welded by this atomic hydrogen process. Chrome-nickel alloys can also be successfully welded. Both these groups require suitable chilling facilities, especially under the weld, to prevent the metal flowing underneath.

TABLE I

Specimen	Width in Inches	Thickness in Inches	Yield Point	Ult. Tensile Strength
1	0.775	0.2460	39,600	63,500
2	0.785	0.2485	45,300	67,000
3	0.784	0.2455	42,000	66,400

Many tests show that, on work that is not too thick, if the edges are brought very close together before welding, no additional metal need be added and there is no noticeable reduction either in section or strength.

Rockwell hardness tests using the diamond cone were made on strips of cold-rolled steel $\frac{3}{4}$ in. wide and 14 in. long, these pieces being cut from sheets having butt welds in the center with a slight amount of Armco filler rod added. The softest areas proved to be within $\frac{1}{4}$ in. of the boundaries of the weld, all bars tested breaking in this area.

These samples were given a tensile test with the results shown in Table I. Test samples made of low carbon steel, 0.20 C., with a double V-weld, using Armco rod for filler gave the tensile values shown in Table II.

TABLE II

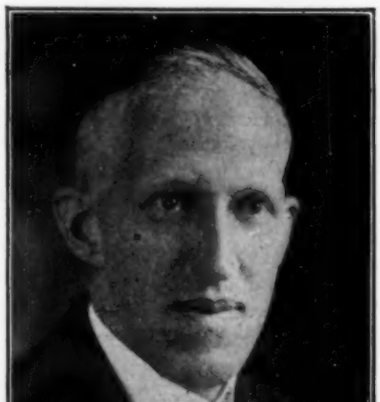
Specimen	Diameter in Inches	Yield Point	Ult. Tensile Strength
1	$\frac{1}{4}$	54,300	62,800
2	$\frac{1}{4}$	46,400	58,300
3	$\frac{1}{4}$	42,200	59,000
4	$\frac{1}{4}$	46,100	57,500

William Blum, New President A.E.S., First Institute Medalist

Award made in recognition of distinguished contribution to the chemical profession through research and achievement in government service

THE American Institute of Chemists awarded its first medal on May 8, 1926, to Dr. William Blum, chief of the electrochemical section of the United States Bureau of Standards. This reward, which will be made annually in the future results from an unusual method of selection which has been fixed by the Institute. Under this plan the committee of award selects from each of three fields—industry, education and public service—the one who has contributed most toward the advancement of the chemical profession. From the three medal candidates thus selected one is chosen each year to receive the gold medal of the Institute.

In making the first award it is peculiarly fitting that Dr. Blum should have been chosen. He is unquestionably an outstanding figure in governmental chemical research. He has been for seventeen years on the staff of the National Bureau of Standards and for the entire period has been contributing much to the high standing of the chemical work of that institution. But throughout much of this period Blum has been more than an investigator. He has been a leader and teacher of industry, particularly the industries using electroplating and electro-forming of metals. One might also say that for this reason Blum would equally well qualify as an industrial investigator or on pedagogic grounds.



William Blum

Not the least of Blum's service has been the result of his inspiring self-sacrificing personality. There are few among chemical investigators who have been his equal in the demonstration of service before self. It is not strange, therefore, that he presented as his metal-award address a discussion of "Science for Humanity Sake." There is no one who is more entitled to speak on that subject than one who has himself been a conspicuous personal example of self-sacrificing service.

Prior to the presentation of the medal and the address of the medalist, Dr. Charles E. Munroe, honorary fellow of the Institute reviewed the life and work of Dr. Blum. The latter was born in Philadelphia, December 28, 1881. He was graduated from the Central High School of that city and attended the University of Pennsylvania from which institution he received his B.S. degree in 1903 and his Ph.D. degree in 1908. Both in his undergraduate and his graduate study he specialized in electrochemistry. From 1903 to 1907 and in the college year 1908-09 he taught at the University of Utah. In 1909, he went to the Bureau of Standards where he has since remained. The Electrochemical Section of the Bureau, of which he is Chief, was created as a result of his studies. He has been the sole or joint author of 31 papers and books, 22 of which have been on electrochemical subjects. His book, "Principles of Electroplating," written in collaboration with George B. Hogaboom, is recognized as the best book in its field.

Dr. Blum is active in the civic, educational and spiritual affairs of his community. He is a member of the Cosmos Club of Washington, the Chemists' Club of New York, and Sigma Xi Society. He is a member of the Washington Academy of Sciences, and a Past President of the Chemical Society of Washington. Within the past month Dr. Blum was elected to the presidency of the American Electrochemical Society in which organization he has for years been a most active member.

Instead of electing to discuss the research in which he has made such a distinguished record, Dr. Blum chose to visualize in his medal address a worthwhile ideal toward which all scientific work should be directed. It is impossible here to do more than recount only a few scattered sentences from his masterly address yet perhaps these will indicate something of the sincerity with which he advocated "science for humanity's sake."

"The justification of science is its possible utility. It should contribute alike to the material, the intellectual, and the spiritual needs of man."

"The best chemist, like the best physician, is the one who teaches his clients how to dispense with his services, and such a one will never lack for other clients."

"It is the duty of the scientist to translate, or have translated, the results of his research that can be understood, and if need be, used by laymen. The work of the scientist is only half done when it is published in the annals of his profession; it must also be made available to all those who can use it. The world demands a living science, not a museum."

"The scientist needs culture as much as culture needs science."

"The chemist who throws an air of mystery about his work, who adds secret 'dopes' to the solutions in the plant, who embellishes his reports with high-sounding terms, unintelligible to the workman or the superintendent, is simply putting himself in a class with the charlatan and the quack. Perhaps he fears that with a little technical knowledge the foreman can get along without the chemist's service. If he can, so much the better, for there are many other tasks awaiting the application of science."

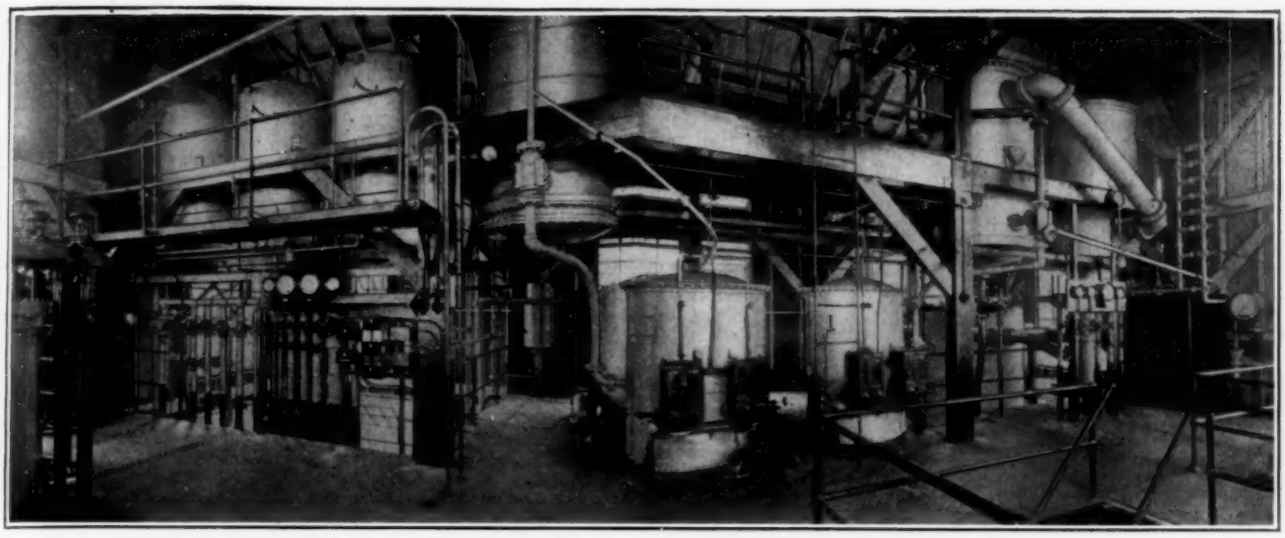


Fig. 1—An Extended View of the Operating Floor
To the right are shown the dephlegmator, condenser and operating control of the rectifying still. In the center are the decanters and to the left are the operating control of the simple still and distributing manifold for the distillate to the various tanks

Manufacture of Motor Benzol

Recovery and purification of benzol as practiced by the Portland Gas Light and Coke Company

By E. L. Hall
General Superintendent, Portland Gas Light and Coke Company, Portland, Ore.

MANY of the benzol plants constructed during the War were inefficient, owing to the speed with which they were constructed. Before letting the contracts for the equipment, the management and engineers of the Portland Gas & Coke Co. investigated the merits of the various equipment and selected that designed by a leading firm of distillation specialists. It is felt that the Portland plant represents one of the best in efficiency and convenience of operation.

Until the winter of 1924, the gas was passed through two centrifugal-type scrubbers consisting of vertical shells approximately 9 ft. in diameter equipped with buckets mounted on vertical rotating shafts and divided into chambers. The absorption oil, which is a petroleum distillate boiling between 450 deg. and 700 deg. F., with a low viscosity and similar to a light lubricating oil, enters the top of the scrubbers and falls into the uppermost bucket from which it is sprayed out through nozzles by centrifugal force and drains into the bucket next below, thus proceeding down to the bottom of the scrubber where it drains into a tank. The gas enters the lower portion of the scrubber and flows across each chamber and up into the next until it reaches the outlet on top of the scrubber. The gas comes into intimate contact with the spray of oil and the benzol and other vapors are absorbed in the oil. Although this type of scrubber appears to have been successful in the gasoline absorption plants when gas comparatively rich in gasoline is scrubbed, the experience in Portland showed an efficiency of only 60 per cent.

It was also found that the absorption oil deteriorated rapidly on account of tar and lampblack being picked up from the gas, which passed through the scrubbers before going through the iron oxide purifiers. It was therefore decided to scrub the gas after it had passed through the purifiers and to replace the centrifugal scrubbers with hurdle scrubbers. These consist of 4 steel towers, 10 ft. in dia. and 85 ft. high. The shells are connected in series so that the gas flows from the bottom to the top of each. The scrubbers are filled with wooden grids constructed of ¼ in. by 6 in. boards on edge with ½ in. spaces between the boards. Each successive layer of grids is laid at right angles to the one below and the bottom edges of the boards are serrated to assist in the even distribution of the oil which is of the utmost importance in obtaining high efficiency. The top of each scrubber is equipped with 36 spray pipes which distribute the absorption oil evenly over the grids. The gas and oil flow is counter-current i.e., numbering the scrubbers 1, 2, 3 and 4 in the order in which the gas flows, the absorption oil enters No. 4 first then it is pumped from the base of No. 4 to top of No. 3 and similarly to No. 2 and No. 1. The oil, which is termed benzolized wash oil, then drains by gravity into an underground tank of 12,000 gal. capacity from which it is pumped to the distillation equipment where the light oil is removed and the debenzolized wash oil returned to the scrubbing system.

The selection of the size of scrubber to give efficient and economical operation presented a problem with several factors, on account of the variation of gas make, which is more than 300 per cent between minimum in summer and maximum in winter, and also that a steady increase in gas send-out is being experienced.

The factors affecting scrubber size are velocity of gas

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flow, time of contact and amount of wash oil circulated. At two modern benzol plants in connection with byproduct coke ovens, when the absorption of the sulphur compounds is not especially important, the gas velocity is from 2 to 3 ft. per sec. and a time contact of not less than 60 sec. in passing through all scrubbers in series is given. The amount of wash oil circulated is between 1½ and 2 gal. of oil per min. per sq.ft. of scrubber shell area. One well-known firm of gas apparatus manufacturers gives 2¾ gal. per sq.ft. of area as required for efficiency of 90 to 97 per cent recovery of light oil.

In determining gas velocity and time contact it is figured that 40 per cent of the shell area is taken up by the grids. With grids constructed of ¼-in. boards, ½ in. apart, the proportion of wetted area to grid volume is 30 square feet per cubic foot.

The Portland scrubbers have an area of 78.5 sq.ft., 40 per cent of which is taken up by the grids, so that the net area is 47 sq.ft. At a maximum gas flow of 900,000 cu.ft. per hr. this gives a velocity of 5.3 ft. per sec. and a time contact of 49 sec. through the 4 scrubbers. With an average gas flow of 450,000 cu.ft. per hour, the velocity is 2.6 ft. per sec. and time contact 98 sec. The above figures are based on the effective height of each scrubber being 65 ft., which is the space occupied by the grids.

In order to obtain the greatest economy in steam and power consumption, it is necessary to keep the amount of wash oil circulated to a minimum, and as this is a factor of shell area it follows that this area must be kept as low as possible consistent with velocity and time contact requirements. In order to cut down the wash oil circulation during the summer months when the gas send-out is low, and still maintain high efficiency, the oil piping is so arranged that it is possible to re-circulate a portion of the wash oil over each scrubber. At Portland this has not yet been attempted but when the gas send-out falls off, re-circulation will be started.

It has been found that with tower scrubbers it is not usually possible to obtain a saturation of the light oil in the absorption oil of more than 3½ to 4 per cent and still maintain a high recovery efficiency. The effect of attempting to obtain too high a percentage of saturation is not only to decrease the total amount of light oil recovered but most of the higher boiling and usually less desirable homologues will be absorbed at the expense of the lower boiling homologues such as benzol, which, due to its higher vapor pressure, is less readily absorbed by the wash oil.

Fig. 2—General View of Crude Light Oil Recovery Plant
The stills and pumps are in the building to the right, the heat exchangers are to the left of the building, and to the rear of these are the wash oil coolers. The tanks are for storage of absorption oil

The efficiency of absorption is dependent on the vapor pressure of the benzol in the gas and in the absorption oil. Given sufficiently intimate contact the benzol will be absorbed until the vapor pressure of the benzol in the gas and in the absorption oil are in equilibrium. The importance of removing the benzol from the wash oil in the still as completely as possible and of having counter-current flow of gas and oil in the scrubbers will be apparent. It is not possible to attain 100 per cent recovery efficiency in actual practice but an efficiency of 95 to 97 per cent may be realized by maintaining the benzol content of the wash oil which last comes in contact with the gas below 0.5 per cent. Also by having scrubbers of sufficient number and height to give a time contact of not less than 60 sec. and circulating sufficient wash oil at a temperature not above 70 deg. F., to cover the entire surface of the grids and to give a maximum saturation of usually not more than 4 per cent (depending on the amount of benzol in the gas) in the absorption oil leaving the bottom of the scrubber through which the gas passes first.

The temperature of both oil and gas should be main-

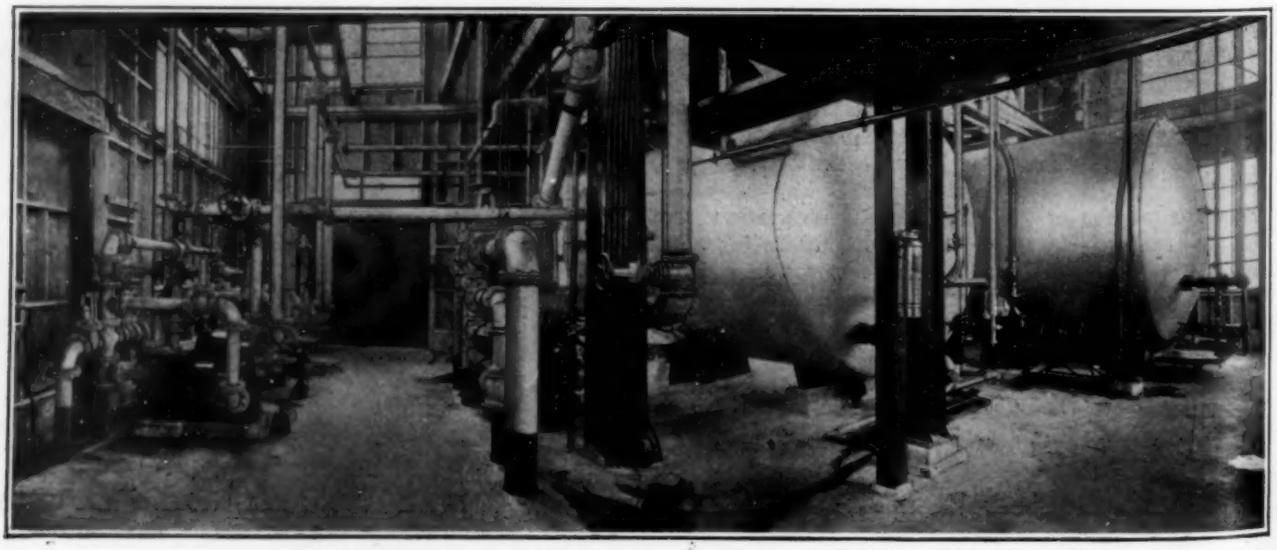

Fig. 3—The Still Kettles and Charging Pumps. These Are on the Ground Floor

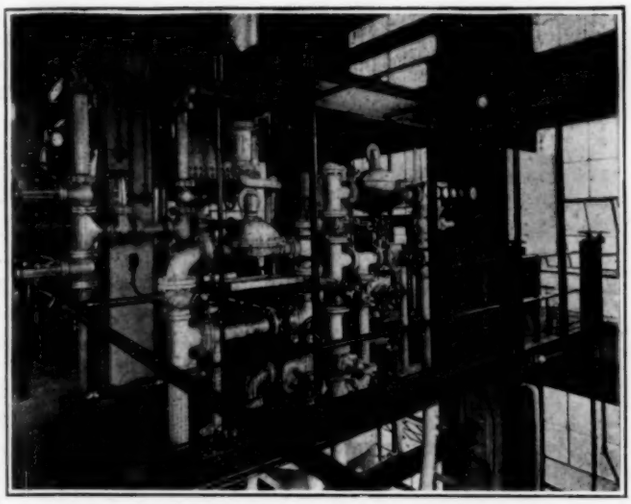

Fig. 4——The Operating and Control Floor
Control is centralized almost entirely on this floor, and one man per shift is all the labor necessary to operate the plant

tained below 70 deg., and if the gas is saturated with water vapor at the temperature at which it is being scrubbed the wash oil should not be allowed to go below this temperature, or water will be absorbed which would decrease the light oil absorption efficiency and tend to form an emulsion with the oil.

The light oil content of the debenzolized wash oil is governed by the efficiency of the still used for removing the light oil. It should not exceed 0.5 per cent and can be kept with proper equipment between 0.25 and 0.35 per cent.

There are several kinds of oil which are suitable for absorbing benzol from gas. The absorption oil used in Portland is known as "straw oil" and is received in tank cars from the California refineries. It is the type of oil most commonly used in the United States, probably largely due to its comparatively lower price.

In the European plants, coal-tar distilleries are used mostly, creosote oil and green oil or anthracene oil which is the next higher fraction to creosote being preferred. The principal requirements of a good absorption oil are:

(1) Low specific heat.
(2) Low viscosity at all temperatures.
(3) Olefine content not over 12 per cent.
(4) High initial boiling point (not below 400 deg. F.).
(5) Low molecular weight.

The distillation equipment at Portland consists of a stripping still equipped with rectifying column in which the light oil is removed from the wash oil; heat exchanger units, in which a large proportion of the heat in the debenzolized oil leaving the still is transferred to the benzolized oil from the scrubbers; pre-heaters in which the temperature of the benzolized oil leaving the heat exchangers is raised by steam to 230 deg. F.; a condenser in which the light oil vapors and steam from the still are condensed and a decanter in which the water from the light oil is separated by gravity.

The distillation is carried on continuously under a vacuum of 20 in. of mercury which lowers the boiling point of the light oil absorbed in the wash oil so that a temperature of 230 deg. F. with the use of steam injected into the bottom of the still is sufficient to vaporize and remove the light oils. The boiling point of benzol is lowered approximately 39 deg. F., under a vacuum of 20 in. of mercury. On stills operating under atmospheric pressure a wash oil inlet temperature of 260 deg. F., is usual and the amount of steam injected into the still is almost twice that required when operating under vacuum.

The still is 8 ft. in diameter and 12 ft. high and consists of 14 ring sections between each of which is a plate on which is mounted 166 bubbling caps and two overflow pipes. The oil after leaving the preheaters enters the top section and overflows into the next section and so proceeds to the bottom of the still. The bubbling caps consist of a cast-iron chimney covered by an inverted cast-iron cap, the rim of which is provided with slots. The overflow pipes maintain a level of oil which is approximately $\frac{1}{4}$ in. above the top of the slots in the bubbling caps. As soon as the hot oil from the preheater enters the vacuum in the top of the still, part of the light oil vaporizes and passes out through the vapor pipe connecting to the bottom of rectifying column. As the oil flows down and across each plate in the still, the steam which is blown in to the bottom bubbles up through the slots in the bubbling caps and vaporizes the light oil, the vapor from which together with the steam continues up through the still and to the rectifying column. The absorption oil, when it reaches the bottom of the still, is stripped of the light oil and has reached a temperature of 220 deg. F. It is then pumped through the tubes of the fifteen heat exchanger units to give up part of its heat to the cold, benzolized wash oil which circulates around the outside of the tubes. In passing through the heat exchanger, the hot oil is cooled from 220 deg. F. to approximately 160 deg. F. and then passes up through a standard cooler, consisting of banks of pipe over which water flows, where the temperature is reduced to between 60 deg. to 70 deg. F. and then enters a storage tank from which it is pumped to the scrubbers, thus making a complete cycle.

The rectifying column is of similar construction to the wash oil still and its purpose is to reduce the amount of wash oil carried over with the light oil vapors. A small stream of condensed light oil is returned from the decanter to the top of the rectifying column and the vapors from the still when bubbling up through the oil on the plates of the rectifying column have a portion of the wash oil condensed out. The bottom of the column is connected by piping to the top of the still so that any excess of oil returns to the still again.

The vapors from the top of the rectifying column

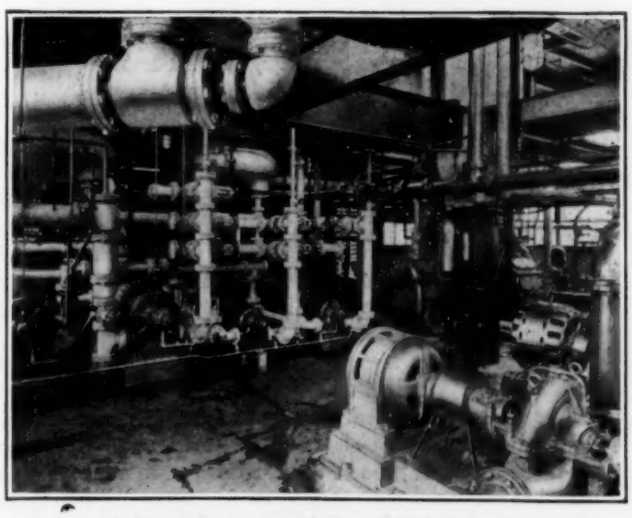

Fig. 5—Direct-Connected Centrifugal Pumps
Nine of these pumps are in continuous operation. The vacuum pumps are shown in the background

enter a tubular condenser where they are condensed by water flowing through the tubes. The condenser light oil and water enter a decanter or separator where the oil and water separate and flow through "look" boxes provided with glass windows. The water flows to a seal pot and thence to the sewer and the light oil to a centrifugal pump which transfers it to a large storage tank at the refinery.

Batch Process Used in Refining Light Oil

The refining of the crude light oil is conducted in a separate plant located away from fire hazard and inclosed in a high wire fence. Unlike the recovery plant it is operated on the batch system in place of continuously. There are refining stills in use, particularly on alcohol distillation which are continuous, but as far as is known they have not been adopted in benzol refining probably on account of the complexity of the mixtures of hydrocarbons of different boiling points which are contained in most crude light oils. The first step in refining is the removal of the small proportion, usually about 10 per cent, of wash oil and a part of the napthalene. This is done by distillation in a 15,000-gal. still consisting of a 12 ft. dia. by 22 ft. long tank or kettle equipped with steam heating coil and steam spray pipe. Above the kettle there is a large rectifying column 8 ft. in diameter and equipped with 20 plates provided with bubbling caps and overflow pipes similar to the still in the recovery plant. Above the still are two tubular water-cooled condensers, the first of which is a dephlegmator or reflux condenser and the second a final condenser. The dephlegmator is provided with a run-back line, with "look" box or sight flow, to top of rectifying column and the final condenser is equipped with a sight flow and line for distillate connecting to decanter which is similar to apparatus at recovery plant. A vacuum pump is provided so that the distillation can be carried on under vacuum. The vapor from the kettle rises through a pipe connecting to the bottom of the rectifying column and after passing up through the column and being "scrubbed" by the condensate returned from the dephlegmator passes into the top of the dephlegmator. The water supply to the dephlegmator is controlled so that the amount of vapor condensed and returned to the column through the run-back line is 25 per cent to 200 per cent of the amount passing on to the final condenser, depending on the purity desired in the final distillate. On the first distillation about 25 per cent is refluxed from the dephlegmator. From the decanter the distillate is pumped to a storage tank and is then known as "once run light oil."

During the later stages of the distillation vacuum is used and steam injected in the kettle to lower the boiling point of the light oil and assist in rapid distillation.

After 3 or 4 charges have been run off, the residue consisting of wash oil and naphthalene is run into open tanks where it is allowed to cool to permit the crystallization of naphthalene, and the wash oil is then pumped back to the oil-washing plant and the naphthalene is shovelled out into drums.

The second step is acid washing, which is performed in a 4,500-gal. vertical agitator 9 ft. in diameter with a cast-iron hopper bottom equipped with water-cooling coils and monel metal shaft and propeller mounted in a cast-iron central pipe and driven by a vertical-type induction motor.

Concentrated 66 deg. Bé. sulphuric acid is fed from a gravity measuring tank into the agitator while the propeller is running. The acid is admitted in portions of 1 per cent of the charge of light oil and the total quantity used is from 3 per cent to 5 per cent. Agitator is run for 15 min. while acid is being admitted and from 15 to 30 min. after acid is shut off.

After each portion of acid is admitted the sludge, which is a thick black tar, is drawn off the bottom of the agitator into the acid boilers in which it is afterwards steamed to drive off entrained light oil and permit the unused portions of acid to settle out of the tar. After the final acid wash the light oil is washed with a 10 per cent solution of caustic soda to neutralize remaining traces of acid. It is then dumped to a storage tank.

The acid wash removes thiophene, olefines and other unsaturated hydrocarbons which tend to polymerize and form gummy deposits in automobile engines. It is a drastic treatment inasmuch as constituents of the light oil which do not necessarily cause trouble are removed also. Much research work on refining gasoline and other light hydrocarbons has been done with a view to finding a less drastic treatment and many methods have been tried at the Portland laboratory but to date have not shown any great promise. Acid treatment is not only open to the objection of causing excessive loss of product (from 5 to 10 per cent) but its use involves corrosion of equipment and risk of injury to operators.

The third step in refining is simple distillation to remove the sulphonation products and high-boiling polymers formed during the acid wash. This is done in a 9,000-gal. batch still provided with a cast-iron vapor scrubber similar in design to a rectifying column and through which hot caustic soda solution is circulated to neutralize the sulphur dioxide in the vapor released by the breaking down of the sulphonates in the still. A condenser and decanter similar to those on the rectifying still are provided and the distillate is run to a tank from the decanter outlet.

After the simple distillation, a viscous residue is left in the still kettle. It is possible to recover from this residue by direct-fire distillation a high-boiling oil and a resin suitable for varnish manufacture.

Motor Benzol Must Pass Doctor Test

Owing to the use of the benzol as motor fuel, it is necessary to reduce the sulphur content to a minimum, the specification requiring a content of not more than 0.1 per cent by weight and that the product will not react with sodium plumbite and cause a darkening of the solution. This is known as the "doctor test." The light oil after its simple distillation is returned to the agitator where it is washed with sodium plumbite which is made up by agitating lead oxide or litharge with a 20 per cent solution of caustic soda. Certain of the sulphur compounds react with this sodium plumbite to form lead sulphide which is drawn off as a black sludge.

The final step is rectification which is done in the rectifying still which has been described. The first fractions which consist of carbon bisulphide and other low boiling sulphur compounds which were not removed by the previous treatments are taken off slowly at about 250 gal. per hr. with a heavy reflux from the dephlegmator so that as sharp a cut or separation as possible can be made. During the removal of "forerunnings" the distillate is tested with phenyl hydrazine and with sodium plumbite, and when an absence of sulphur is shown, the distillate is run to motor fuel benzol tanks, or cuts are taken off for pure benzol, or 90 per cent benzol, as desired.

When is Gasoline Satisfactory as Motor Fuel?

A plea for significant specifications based on performance of the product in service rather than on laboratory tests

By H. C. Dickinson

Chief, Heat and Power Division, United States Bureau of Standards

WHEN gasoline was a byproduct mainly from Appalachian crude oils it was tested and sold on a basis of density or Baumé gravity. When a wider variety of crudes became available and it became profitable to put into gasoline for motor car fuel as wide a range of volatilities as the trade would accept, the Engler distillation test was generally adopted and standardized by the American Society for Testing Materials. This has largely displaced the gravity test as an index of gasoline quality, although "gravity" is still widely used and often misinterpreted.

It was not until about 1920 that any serious and systematic effort was made to determine what gasoline for use as a commercial automobile fuel ought to be. It is sometimes a long step from a knowledge of what a product ought to be to a specification including instructions as to how it shall be tested.

A great many tests on which specifications are based represent hardly more than something which can be done to a product and which will yield the same numerical result whenever applied to the same product. There is too often no direct or logical relationship between the test results and the performance of the product in service. Such tests and specifications are often justified for purposes of identification but when applied to products of radically different character, all of which may be satisfactory for a given service, they lose their value or even become misleading. This would apply to a gravity test and to a color test for motor gasoline if these tests are intended to measure service value of the product.

In what follows, therefore, the question of what a motor gasoline should be is discussed only from the point of view of what the motor requires.

Volatility from the Engine Standpoint

Under operating conditions air and gasoline spray enter the manifold of an automobile engine. Here they are intimately mixed by turbulence of the air stream, heated to some extent by contact with the walls of the manifold and enter the cylinders in about the correct proportions. Entering through the intake valve still further increases the turbulence and consequent mixing of the charge. Generally, the liquid is not all evaporated at this stage, but probably much of it is in the form of small droplets which are further vaporized by mixing with the residual hot exhaust gases in the cylinder, by contact with the hot cylinder wall, and by adiabatic compression of the charge before ignition. Hence, under ordinary running conditions little if any liquid should remain at the time of ignition.

What little gasoline may remain in the form of droplets suspended in the air at the end of the compression stroke is probably vaporized and burned during the power stroke. However, if the cylinder walls, with their film of lubricant, are at too low a temperature, liquid particles striking them will be dissolved in the oil film, or, under extreme conditions, fuel vapor may be condensed on the walls. The oil thus diluted in the cylinder is interchanged with oil in the crankcase by the reciprocating action of the piston and thus dilutes the crankcase oil.

There is, therefore, a critical temperature for any particular fuel mixture ratio and engine above which all the fuel will be evaporated before the charge is fired and below which it will not. Similarily, there is a critical temperature above which fuel will not be condensed or dissolved in the oil film to any serious extent and below which it will be condensed and dilute the lubricant. Tests and experience have shown that the latter temperature imposes the more serious limitations on the use of fuels of low volatility. When means are adopted for decreasing dilution, by higher operating temperatures or otherwise, the requirements for a good fuel are correspondingly changed. The higher the temperature, the more favorable the conditions for fuels of low volatility. Also what may be good fuel for the car operated for long periods with few starts and stops, i.e., with few periods of cold operation, may not be good fuel for a car operated with frequent stops and cold starts.

Since the operating conditions and therefore the temperatures occurring in existing engines are fixed by the design and type of service, it may be deduced at once that a gasoline should be capable of substantially complete vaporization from the cylinder walls under ordinary conditions of operation. What these ordinary conditions are and what the corresponding volatility of gasoline may be is, of course, a matter of experience and the results are subject to revision as engine design and conditions of operation change.

It should be noted that gasoline in the engine is vaporized in the presence of, and approximately in equilibrium with, all the vapor previously formed, whereas in the Engler distillation the vapor is drawn off as it forms. In such a distillation vaporization of the heavier portions of the fuel takes place, therefore, not in equilibrium with all the vapor previously formed, but with only that of the heavier constituents. In other words in the engine, vaporization is a *continuous* process while the Engler distillate is a *batch* process and the two are not comparable. The two do not give the same results by any means. Moreover, the Engler distillation takes place at atmospheric vapor pressure, while the vaporization in the engine takes place at a partial

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pressure of gasoline vapor of a few centimeters of mercury, which makes the results of the two types of distillation even more unlike.

It may be stated most emphatically, therefore, that with reference to engine requirements a gasoline should be tested for volatility by some means which will give definite information regarding the behavior of the fuel at vapor pressures and under the other conditions existing in the manifold and cylinders. The temperature at which substantially complete vaporization takes place under such conditions indicates the operating volatility of the fuel, and this volatility for a satisfactory motor fuel should be such that dilution of the crankcase oil is not excessive under expected conditions of engine operation.

Starting Requirements of Fuels

What has been said above regarding volatility applies to the substantially complete vaporization, in other words, to the "upper end" of the distillation range. Initial starting depends upon the low end of the range. In order to start an engine an explosive mixture must be formed in the cylinder by vaporization of the lighter portions of the fuel into air. Without artificial heating, it is ordinarily necessary to enrich the mixture by supplying an excess of fuel by choking or priming, this supplying the necessary amount of the more volatile portions which will evaporate at the existing temperature to form an explosive mixture. Reduction of manifold pressure also assists in increasing the vapor content of the mixture.

Ordinarily it is assumed for starting purposes that not more than from six to ten times the normal amount of fuel can be supplied by usual methods of choking. It has been found that under extreme conditions starting depends upon vaporization of the lowest boiling 10 per cent or 15 per cent of the fuel as judged by the Engler distillation. Unfortunately the standard method of making this test gives very erroneous results as to the initial boiling point due to thermometer lag. If the procedure were modified to correct this error the 0 to 15 per cent region of the Engler distillation curve would probably be of more value in predicting starting qualities of gasoline. This test is decidedly inadequate but not enough information is at hand to recommend a more satisfactory one. But even with present test conditions it is safe to conclude that the temperature below which 10 per cent of the fuel has gone over in the Engler distillation may be taken as a rough index of the relative starting qualities of different gasolines.

Starting requirements differ so radically from winter to summer and from north to south that volatility of the initial fraction should be adjusted to temperature conditions in so far as this is commercially practicable. As a general statement one can conclude as to volatility requirements that the automobile engine demands a satisfactory initial volatility, roughly represented by the 10 per cent point of the Engler distillation, and a satisfactory upper temperature limit for complete evaporation (as described above). Nothing else appears to be important as far as volatility is concerned.

Anti-Knock Qualities Desirable

The compression ratio, therefore the thermal efficiency, of the automobile engine is limited by the tendency of fuels to knock or detonate at high pressures and temperatures. Increased compression ratios might save much fuel. Straight-run gasolines differ in anti-knock qualities, as e.g. West Coast crudes produce fuels much less subject to this trouble than Appalachian or Mid-continent crudes. Cracked gasolines are better than most straight run gasolines although straight California gasolines may be better than some cracked gasolines. Benzol and other aromatic compounds reduce the tendency to detonate. Certain "dopes," particularly tetra-ethyl lead, have the same effect even when used in very small amounts.

The popular demand for anti-knock fuels has led to the general marketing of special gasolines of this class. In general, there is not much to be gained by their use in present engines except when high compression or collection of carbon deposits have increased the tendency to knock. Under these conditions anti-knock fuels may give better economy, as well as more satisfactory operation, and may lengthen the time between carbon removals. There is little doubt that the general distribution of fuels which do not knock will promote the use of engines of increased compression ratios and consequent lower fuel consumption, and will increase the demand for better fuels of this type.

There is at present no satisfactory test for the tendency of a fuel to knock, except an actual trial in an engine. Several different types of engine test are in use but none is standard.

To be satisfactory a fuel should pass a test which will define its tendency to detonate, and it should have such characteristics that the engine in which it is used will not knock noticeably under any reasonable conditions of speed and load when reasonably free from carbon deposits.

Gum, Sulphur and Corrosion Troubles

Collection of gum on intake valve stems and elsewhere is sometimes, though rarely, a cause of serious trouble. The conditions are such that gasoline spray mixed with air impinges on hot iron. Some of the gasolines less subject to knock are more liable to form gums. There is as yet no generally accepted test for this sort of gum formation which is satisfactory. The commonly used copper dish method of test is distinctly wanting in reproducibility of results and brings many difficulties in standardization. There is need of a satisfactory test to determine the degree of gum formation which is likely to occur under conditions existing in the engine. A satisfactory gasoline should be substantially free from such tendency.

A frequent cause of damage to automobile engines is corrosion of bearing parts which can often be traced to the presence of sulphurous or sulphuric acid in the crank case. This appears chiefly when fuels containing appreciable amounts of sulphur (over 0.1 per cent) are used under operating conditions of low temperature such that there is condensation of water from the exhaust gases.

Acceptable tests for sulphur content are available and better ones are being developed. As engines must be operated at times under conditions such that water does condense a satisfactory motor fuel should not contain more than 0.1 per cent of sulphur.

Corrosion of fuel tanks, lines, and carburetor parts is not of common occurrence. When present it may or may not be due to sulphur compounds. Certainly some of these do not cause corrosion of this kind. When such corrosion does occur, however, it may be very troublesome. A satisfactory gasoline should, therefore,

pass a rigid test to determine whether it will cause corrosion when in contact with copper, brass or tinned or galvanized iron parts at ordinary temperatures. No test has been standardized for all of these metals but the accepted copper corrosion test is probably sufficient.

Other tests such as color, odor, gravity, staining on evaporation, etc., which have been used, appear to bear no real relationship to engine requirements, other than as possible indices of qualities already discussed.

Two of the most important characteristics of motor fuels have been omitted entirely from the foregoing discussion as they are from usual specifications. These are the heat of combustion in B.t.u. per gallon or calories per liter of the liquid fuel and the heat of combustion per unit volume of the explosive mixture. The former is proportional to the total amount of work which can be obtained per gallon of fuel, the latter to the moving power which can be produced by a given engine.

The reasons that these two important factors can be neglected in specifications are that the heats of combustion per gallon of petroleum products in the gasoline range and of the usual blends of these with aromatic hydrocarbons are substantially alike, and that the heats of combustion of the air-fuel mixture formed from any of them are even more nearly the same. If alcohols or blends containing them were to be considered the heat of combustion of the liquid would need to be specified, but even here the heats of combustion of the air-fuel mixture are substantially the same.

Present government specifications which are met by the average motor gasoline on sale embody the principles discussed above in so far as the necessary tests have been developed and generally accepted. Accepted test methods have been the result of long continued development, and modifications of them or the substitution for them of other and better methods must necessarily also be gradual. Much is being done by the research laboratories of the Government, as well as by those of the petroleum and automotive industries toward the better realization of the ideal specification for motor fuel.

Scottish Oil-Shale Industry Uneconomic

A court of investigation of the Scottish oil-shale industry has issued a report showing that production of shale oil in Scotland under present conditions is uneconomic because of lower costs of oil products imported from over-seas. In addition, the price of by-products of shale recovery have been lowered by English and German competition. The court, nevertheless, inclines to opinion that shale mines should not be allowed to become derelict. It argues that the mines would be capable of larger output in an emergency and that improvements in technique may be anticipated. The industry employs 7,600 workers. Production of petrol from shale last year was only one per cent of total consumption in Great Britain. There must be either reduction in wages or government subsidy. The court suggests government should consider giving shale companies assistance through a favorable admiralty contract, which in effect would be a subsidy.

This confirms the report by accountants appointed by the British Board of Trade who investigated the economic status of the Scottish industry and reported their findings in October, 1925.

Vapor Phase Catalysis on Large Scale

Oxidation of aromatic compounds made commercially feasible by development of ingenious mercury-cooled converter

Important new work on the commercial feasibility of catalytically oxidizing aromatic compounds in the vapor phase was described by Charles R. Downs at a joint meeting of the American Section, Society of Chemical Industry, American Chemical Society, American Electrochemical Society, and the Societe de Chimie Industrielle held at the Chemists Club on Friday, April 16.

The work on the vapor phase catalytic oxidation of organic compounds as carried out by many investigators in the past has shown a lack of appreciation of the very exact temperature control required. The result has been that either complete combustion occurred or only traces of partial oxidation products were obtained. These reactions never reached the stage of commercial exploitation.

There is a range of temperature above which the products are only those of complete combustion and below which no reaction takes place. The problem is therefore one of heat removal at the same rate as it is formed. It is not a simple cooling action but a temperature sustaining action as well. Within this range of temperature the velocity of the desired reaction increases and since the production of the equipment per unit time is important in any commercial process, the temperature selected must be as high as consonant with yield. Since we cannot fix the temperature of every small particle of catalyst in a mass of the same, we obtain a combination of partial oxidation and complete combustion reactions. A point is then found by trial which gives the best average results.

Laboratory equipment was described, which although admittedly not perfect for a theoretical study of these highly exothermic reactions, was a compromise between ease of handling and good temperature control. Having once gotten favorable results in the laboratory, the transfer to large scale equipment was necessary with provision for equivalent refinement in temperature control.

An agitated lead bath may be used in the laboratory in which a single reaction tube is immersed but upon expansion into a plant converter with hundreds of tubes, the maintenance of a uniform temperature around each individual tube is possible, although difficult, as the removal of heat depends upon the specific heat of the lead with a simultaneous rise in its temperature. Apparatus using boiling liquids such as mercury and sulphur was described. Here the heat is removed by the latent heat of evaporation of a liquid boiling substantially at the temperature of reaction. More or less heat generated in the catalyst merely causes more or less liquid to boil without change in temperature and all parts of the liquid bath are uniformly hot. Each tube in such a large converter functions like its companions and moreover, like the single laboratory tube. Hence, laboratory results can be translated into the plant.

Mention was made of the organic products made by this method and of their useful application in new commercial fields. So far only the aromatic compounds have been intensively studied and the aliphatic field has been largely neglected.

Application of Research to the Rubber Industry

How rubber technology is gradually emerging from a period of secret formulas and empirical development into an era of scientific achievement.

By R. P. Dinsmore
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RESEARCH in the rubber industry may be said to date back to the time of the discovery of vulcanization by Charles Goodyear in 1839. Since that time many notable contributions have been made to the art of rubber manufacture, one of the most important being the use of organic catalysts by George Oenslager. Nevertheless, a new investigator in the field would be astonished by the inadequacy of our knowledge, both with regard to the nature of rubber itself and the mechanism of vulcanization. A little reflection, however, would convince him that while the manufacture of rubber articles has been carried out in this country for over three-quarters of a century, it is only in the last twenty years, since automobile tires have come into use, that the rubber industry has grown by leaps and bounds from puny infancy to powerful manhood. We need, therefore, feel no astonishment at the paucity of general information which has been obtained. Perhaps as we consider the complexity of the material in question, we may congratulate ourselves on the progress which has been made.

Briefly, we can say that industrial research passes through several phases of evolution. The earliest stage involves the more or less random observation of phenomena. Next an effort is made to study certain problems of immediate interest, by means of deductions drawn from known scientific laws, with the supplementary help of empirical data. A later phase is the application of the same method to problems of a more general nature, the solutions of which would not find immediate application. The most advanced stage involves investigation with the purpose of establishing new generalizations. We may consider that research in the rubber industry has passed through the two initial stages and is now well launched in the third. As yet, however, there seems to be little immediate prospect of its reaching the ultimate development.

Passing of the Pharmaceutical Era

Early developments in the compounding of rubber with non-rubber materials were influenced by the desire for colors, which were obtained by the introduction of pigments. The results of the use of these materials led to the use of fillers which were not coloring agents, but which served to cheapen the product. Observation eventually disclosed the fact that certain ingredients produced desirable properties—not obtainable by the use of rubber alone—and then the period commenced which might be termed the pharmaceutical epoch in rubber development. This was a period when secret formulas and specifics were the order of the day. Little attempt was made to determine the causes of the various results. It was not until the automobile tire had developed to take an important place in industry that some attempt was made to find out why one filler strongly modified the character of the rubber stress-strain curve, while another merely shortened it. The effect of particle size and the nature of the surface became subjects of importance. In short, the industry began to see the insufficiency of unrelated facts and began to search for general principles.

The discovery of organic catalysts, while undoubtedly based on much more reliable theoretical grounds than that of vulcanization, nevertheless of necessity was founded on highly empirical data. The true mechanism of vulcanization, by means of catalysts, is not yet understood. Here again, for a long period, the industry was content to let theoretical fundamentals rest, and devote all energy to the discovery of new and more powerful catalysts, basing its researches on a few simple relationships established by known successful materials.

Manipulation and fabrication of rubber have, of course, undergone marked changes. These changes have been largely based on the results of trial and observation of failure. Only recently have real attempts been made to obtain quantitative relationships between such factors as the heat evolved during manipulation, the energy consumed, and the properties of the finished material. The question of the temporary change of state and the permanent modification of structure and how these factors may be controlled by temperature and mechanical working, has only been touched upon.

The design of the articles to be manufactured from rubber, particularly of tires, has been largely a question of selection by trial. Certain simple mechanical principles have been employed, although, in many cases, only in a qualitative manner. The mechanics of design is at present in a very elementary state. This is partly due to the extreme variability of the stresses involved and partly to a lack of knowledge of the properties of the rubber and fabric. In this connection it is interesting to note that both rubber and cotton cord have peculiar stress-strain properties. In the case of the rubber the peculiarities are due chiefly to internal structure, while in the case of the cord, the manufactured construction introduces anomalies. Rubber has a very high elongation and tensile strength combined with a somewhat imperfect elasticity. The shape of the stress-strain curve, and the rapidly changing cross-sectional area at low loads, introduce factors which are not encountered in ordinary materials. Likewise with cord constructed for tire fabric, the stress-strain properties are unusual. The elongation at break is low but the elongation at low loads is relatively high. The elasticity varies widely with such factors as the amount and character of the twist and size of yarn. Thus we have two materials with unusual and different stress-strain characteristics, which must be bonded together physically, to form a coherent unit, capable of resisting stresses without permanent deformation, and able to maintain their bond under rapid flexing. It has, therefore, become no small portion of the task of rubber research, to obtain empirical data concerning the effect of variations in design upon the life of the product. A secondary stage of development has commenced whereby an effort is being made to reproduce service conditions in the testing laboratory, where control is simpler and tests are more rapid.

Another aspect of serviceability is the ability to resist the chemical action exerted by the environment dur-

Based on a paper presented before the Section of Social and Economic Sciences at the Kansas City Meeting of the American Association for the Advancement of Science.

ing the natural life of the product. This is necessarily an investigation involving chemistry, but one in which chemistry is not sufficient. Progress has been made in the direction of explaining the phenomena involved. Progress, however, has been slow, due not so much to the failure to apply general principles as to the selection of the principles applied. Oxidation is known to be the invariable cause of the perishing of rubber. It is not clear, however, why the tendency to oxidize increases with the extent of the vulcanization, nor why certain of the physical properties are affected before others. The indications are strong that the explanation lies within the realm of colloidal and physical chemistry, where effects due to structure are taken into account. Neglect of this field has undoubtedly retarded progress.

Thus we may see that the research activities of the past have been confined largely to the random collection of facts, and the application of general laws (supplemented by empirical data) to problems of immediate importance. A certain amount of work has been done on problems of a general nature, but particularly in the field of design and manipulation the lack of systematic knowledge is striking.

Application of Engineering Principles

Looking ahead to the tendencies for future developments, certain conclusions are forced upon us. In the first place it is obvious that in the branches of the art which most resemble those of other industries and which therefore employ many well-known principles and processes, there is the least demand for the establishment of new generalizations, and the greatest demand for the intelligent application of those principles which are well-known and pertinent. On the other hand, those branches of the art which differ most from other industries and regarding which the least amount of general knowledge is available, will profit most by investigation of a fundamental character. Thus the design of machinery, for use in a rubber factory, does not involve the use of fundamental principles any different from those employed in the design of a machine for a steel plant, a cotton factory, or any other industry. Clearly, here the developments must involve new combinations made by the expert application of known principles. Somewhat similar is the problem of design of product. Here the question is largely one of the application of known principles of mechanics. However, the quantitative relationships have not been well worked out and some essential data are lacking regarding certain properties of fabric and rubber. Obviously these wants must receive the first consideration. The collection of these data will be greatly facilitated by the increasing use of laboratory tests to determine the serviceability of the product. The development of such tests involves a study of the stresses which occur in service and their application in the laboratory.

When we consider the relationship of the composition and structure of the rubber and fabric to their performance in service, both with respect to mechanical and chemical action, we realize that there is little general information to guide us. As previously indicated, with regard to rubber, no rapid advance can be expected if research is devoted to the composition of a material, where structure evidently plays an equally important part. The same thing is true of cotton. Hence we may expect that the problems of vulcanization, pigment reinforcement, and resistance to oxidation, which have perplexed us in the past, will only be solved when more general information is available regarding the combined effect of chemical and structural behavior.

Briefly then, we may expect research in the rubber industry to follow certain rather definite lines. In the province of manufacturing equipment the advances will be made in new combinations of old principles. The design of product may be expected to advance through the systematizing of present knowledge and the establishing of quantitative relationships between the stresses which are now treated in a qualitative way only. This systematizing will be accelerated by the gradual substitution of laboratory tests for actual service tests. On the chemical side the mechanism of vulcanization and of pigment reinforcement will be studied concomitantly with the physical and colloidal structure of the rubber. Eventually this should lead to a practical synthetic rubber, since present synthetic rubbers are successful chemically but failures structurally. Studies in cotton will naturally proceed along the lines of correlating chemical and physical structure with fabric properties.

Looking ahead to the final stage when the rubber industry may occasionally contribute generalizations of broad scientific application, it seems probable that these will come through the chemical and physical-chemical studies of rubber and fabric, because it is in these branches where general knowledge is most lacking in this industry.

If the author's course of reasoning has been clear, it should be almost self-evident that the type of personnel to carry on research work must vary with the character of the work. In the primitive stages, the practical, untrained man was sufficient. Later men with technical training were substituted or added. In the present phase more and more recourse is being made to highly trained specialists, and this tendency will undoubtedly become more and more marked. It is fast becoming the most important work of the research director to see that the work is properly classified and that the proper specialist is selected for each job. The necessary balance must be maintained between applied research for immediate return, research for more remote applications, and fundamental research, the application of which cannot with certainty be predicted. Without the proper balance between the first two the industry will soon suffer, and only by the adoption of an adequate proportion of fundamental research can true scientists of the highest caliber be attracted and retained in the industry.

Thus we may secure a result profitable to industry and satisfactory to science. Progress, which follows definite laws, demands a balanced growth between inductive and deductive knowledge. The interrelation of phenomena maintains the balance. Each generalization eventually becomes inadequate to explain all the phenomena to which it is applied, and from the exceptions arise new generalizations. Likewise the aggregation of new facts regarding certain classes of phenomena, eventually becomes too unwieldly to utilize and, from their classification, generalizations arise, from which new facts may be predicted.

It is well to remember that discovery of the laws of nature constitutes only a portion of living, while conformation with those laws governs the very character and duration of existence. Likewise, the business man should be reminded that he can be successful in his operations only insofar as he conforms to the laws of nature, a knowledge of which is therefore a prime requisite.

Formation of Powdered Copper in Anode Mud

Usual explanation of precipitation of finely divided metal at anode is shown to be incorrect

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IN COPPER refining, an appreciable amount of finely divided copper appears in the anode mud, due to the reaction:

$$2\,Cu^{+} \rightleftarrows Cu + Cu^{++} \qquad (1)$$

The question to be discussed in the following note is why this reaction goes from left to right. Text books on electrochemistry give as the reason the dilution that the solution at the anode undergoes when diffusing into the body of the electrolyte,[1] but a closer examination will show this explanation to be incorrect.

At the anode the two kinds of copper ions are in equilibrium with each other, as they must be produced in such concentrations as to make the two electrode potentials Cu/Cu++ and Cu/Cu+ equal to each other. The only reason the above reaction should take place is therefore that the equilibrium is disturbed. This might occur either by a dilution of the solution as a whole or by a change in temperature.

If the solution is diluted, the equation

$$K = \frac{(Cu^{++})}{(Cu^{+})^{2}} \qquad (2)$$

must be satisfied both before and after dilution, but if the temperature falls, the value of K increases[2]; that is, metallic copper is deposited by equation (1).

Since the anode solution is more concentrated than the main solution, when this diffuses into the main solution it becomes diluted. This, however, cannot be the reason equation (1) proceeds from left to right, for if the effect is actually calculated from equation (2), it will be clear that dilution ought to make the reaction (1) go from right to left, in which case there would be no deposition of copper.

Writing x for (Cu^{+}) and y for (Cu^{++}), equation (2) becomes

$$Kx^{2} = y$$

and differentiating

$$2Kx\,dx = dy$$

Dividing through by (2) gives

$$2\frac{dx}{x} = \frac{dy}{y} \quad \text{or} \quad \frac{dx}{x} = \tfrac{1}{2}\frac{dy}{y}$$

That is, if (Cu^{++}) decreases in concentration by 1 per cent by the anode solution mixing with the body of the electrolyte, (Cu^{+}) must decrease only ½ per cent. But since dilution by mixing at first decreases the concentration of both kinds of ions by the same fractional amount, more Cu^{+} ions must form so as to make the resulting fractional change in concentration of Cu^{+} ions only one-half the fractional decrease in (Cu^{++}) caused by the dilution; that is, Cu^{+} ions must be *produced* and not used up by dilution.

Allmand and Ellingham in their "Applied Electrochemistry" try to avoid the difficulty by using another equation. The following equilibrium is deduced, on the theory that the cuprous copper is nearly entirely in the form of the complex $CuSO_4^{--}$:

$$(Cu_2SO_4)^{2} = K_2(CuSO_4)^{2} \qquad (3)$$

Even if this equation were correct, it would not apply to this case, for undissociated salts are not under consideration. Moreover, in the deduction of equation (3) $(CuSO_4)$ is substituted for (SO_4^{--}) which evidently is not correct.

However, if this equation is admitted, it is true that according to it the fractional decrease in concentration of Cu_2SO_4 on dilution would be 1½ times that of $CuSO_4$ and "Consequently when the concentrated equilibrium solution produced at the anode has diffused away a little into the bulk of the electrolyte, it will have become supersaturated with respect to cuprous copper and the reaction $2\,Cu^{+} \rightleftarrows Cu + Cu^{++}$ will take place." It is shown above, however, that this ionic reaction will not take place on dilution, and the use of equation (3) to justify this statement is not allowable. If equation (2) is correct, equation (3) must be wrong.

The only explanation left for the fact that (1) does proceed from left to right is that there is a slightly higher temperature in the immediate vicinity of the anode than in the main body of the solution and that the reaction takes place as a result of cooling from the temperature of the junction of the anode and the solution to the temperature of the body of the electrolyte. The effect of fall in temperature must, of course, overpower the opposite effect due to dilution.

This explanation is in agreement with the facts, for in copper sulphate solutions there is a heating at the anode,[3] and on cooling the equilibrium represented by equation (1) is shifted from left to right.[3]

There are not enough data at present to compute the amount of powdered copper formed and to compare with experiments.

The same change in explanation must also apply to the gold in the anode mud in gold refining. In the case of gold Foerster (l.c. *Elektrochemie wäss. Lösungen*) does not say the equilibrium concentration (Au^{+}) is exceeded by dilution, but says that *if the equilibrium concentration* (Au^{+}) *is exceeded in any way* then the equilibrium is restored by the reaction:

$$3Au^{+} = 2Au + Au^{+++}$$

No explanation is suggested as to how or why the equilibrium concentration is exceeded.

On account of the importance of the industry in which this reaction occurs it may be worth while to call attention to the error involved in the usual explanation, so that it will not be handed on indefinitely.

[1] Foerster, *Elektroch. wäss. Lösungen*, p. 411 (1922).
[2] Foerster and Seidel, *Z. anorg. Ch.*, Vol. 14, p. 106 (1897).
[3] J. Gill, *Wied. Ann.*, Vol. 40, p. 137 (1890).

Oil Viscosity and Starting Torque

The Bureau of Standards has investigated the relation between oil viscosity and the torque required to start an automobile engine and to bring it up to a given speed. From the results thus far obtained it appears that although the viscosity of the oil does have a pronounced effect upon the power required to crank the engine at speeds of 100 r.p.m. and higher, it does not have any appreciable influence upon the torque required to start the engine rotating.

Another investigation of the Bureau relates to the characteristics of airplane engine lubricants under variable temperatures, and more particularly in the lower range.

Soda Ash and Caustic Soda Finding Wider Consuming Outlets

An Exposition of Methods Used in Producing and Marketing These Alkali Products With Distribution Given According to Industries

By E. M. Taylor,
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CALCINED sodium carbonate, or soda ash as it is known commercially, holds the premier position in the alkali group from a tonnage standpoint. The general quotation of producers refers to a material containing 58 per cent sodium oxide. Prior to June, 1923, it was the custom to quote prices according to the so-called "New York and Liverpool test." According to this test the quoted prices were on a basis of 48 per cent of actual alkali content but the method of computing the composition of soda ash from its chemical analysis was based on erroneous chemical equivalents which overstated the purity of the product. In 1923 this method of quoting, which had originated in England, was discarded and domestic producers adopted the policy of quoting on a flat price based on the actual percentage of sodium oxide contained in the soda ash.

MARKETING

Soda ash is a basic chemical used in the manufacture of so many products that it easily holds the ranking position among the alkali group. Caustic soda also is of prime importance by virtue of its large tonnage and its widespread use in industry. The growth of these chemicals in domestic markets is discussed in Mr. Taylor's article as well as marketing methods, price fluctuations, and the various outlets through which distribution is effected.

CHEMICAL PRODUCTS

Domestic production of soda ash has practically doubled in the last 10 years. In 1914 the output was 935,305 short tons while estimates place production for 1925 at 1,810,000 short tons with a marketable value of approximately $45,000,000. However, a part of the production is consumed at the point of origin with a corresponding lessening in the value of the quantity actually marketed as soda ash.

With due allowance for variation in the carryover of stocks, consumption of soda ash may be regarded as following closely the fluctuations in production. The glass trade is the largest consumer of soda ash with the next largest quantity going into the manufacture of caustic soda. Soda ash also is used to a large extent in the production of other chemicals and a wide outlet is found in the soap trade and in making modified sodas and cleansing compounds. A fair idea of the distribution of soda ash by consuming industries may be gained by reference to an estimate published in the January, 1926, issue of *Chemical & Metallurgical Engineering* and which gave details of consumption as shown in accompanying Table II.

In marketing soda ash, the 58 per cent material is sold as "58 per cent light" and "58 per cent dense." As the names indicate, the distinction is entirely one of density, the dense ash weighing about twice as much per unit as the light ash. Dense is given a preference when consumers desire small bulk and a large part of the output goes to glassworks. Quotations show a range according to packing, the lowest prices applying to bulk lots and higher prices obtaining for bags and barrels. As a rule large consumers place contracts for their annual requirements with the heaviest contracting period coming in the final 3 months of the year. There is also a distribution through dealers who carry stocks at the consuming centers.

Export demand is handled through the U. S. Alkali Export Association. Competition in foreign markets is very keen, with Great Britain, France, and Germany in a position of advantage in many instances. Prior to 1918 the Department of Commerce did not issue separate figures for exports of soda ash. The first returns were for the fiscal year ended June 30, 1918, when exports were 198,752,457 lb. For the calendar year 1925 exports were 32,380,108 lb.

The Bureau of the Census in reporting domestic production of soda ash gives the following data for the census year specified:

DOMESTIC SODA ASH PRODUCTION

	1923	1921	1919
Soda ash, total production, tons	1,707,987	959,593	1,507,424
Ammonia-soda process, tons	1,674,234	929,448	*
For sale, tons	1,225,027	746,183	1,033,480
Value	$31,413,210	$28,316,435	$31,195,149
Other processes, tons	33,753	30,145	*
For sale, tons	33,753	30,145	*
Value	$1,013,956	$1,030,991	*

* In the report for 1919 separate figures were not given for the ammonia-soda process and for other processes.

DISTRIBUTION OF SODA ASH BY INDUSTRIES

Consumed by:	1924 Tons	1925 Tons
Glassworks	510,000	520,000
Soap	130,000	155,000
Pulp and paper	60,000	75,000
Textiles	30,000	35,000
Petroleum	20,000	25,000
Water softening	75,000	75,000
Cleansing compounds and modified sodas	75,000	100,000
Caustic soda	417,000	465,000
Bicarbonate of soda	99,000	100,000
Other chemicals	160,000	185,000
Exports	14,000	16,000
Miscellaneous	46,000	59,000
Totals	1,636,000	1,810,000

With the exception of war years, when prices for light ash went up to $4.50 per 100 lb., market values have been determined largely by production costs as

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established by raw materials, labor, etc. That is, there has been no change in process or in technology which has been a factor in influencing values. In 1913 the quotation for light 58 per cent soda ash was 85c. per 100 lb. in bags. The current price is $1.38 per 100 lb.

Caustic soda, which is the commercial name given to sodium hydroxide, is a white caustic substance of high alkali strength. It is sold in solid form or crystals, ground, and in flakes. There, also, is a limited sale in liquid form but this is subject to a disadvantage of freight charges where long hauls are to be made and by far the greater part of trading is for the solid forms. As in the case of soda ash, quotations formerly were according to the "New York and Liverpool test" but since June, 1923, sales have been made on a flat price based on actual alkali content. The general quotation applies to a material containing 76 per cent sodium oxide. It is produced by the ammonia-soda process and by the electrolytic process. Official figures show that in 1923 slightly more than 70 per cent of domestic production was by the former process.

Domestic production has increased rapidly in recent years. In 1910 the home output was reported at 134,228 tons. Abnormal demand during the war years brought about sharp increases in production which culminated in a record output of 513,363 tons in 1918. The quieter position of consuming industries after the war resulted in reduced production of caustic soda but in 1925 demand again assumed large proportions and it is estimated that domestic producers turned out close to 500,000 tons. Official figures for the census years give production as follows:

TABLE I—DOMESTIC PRODUCTION OF CAUSTIC SODA

	1923	1921	1919
Caustic soda, total, tons	436,619	238,691	312,736
Ammonia-soda process, tons	314,195	163,044	.....
For sale, tons	311,838	162,906	302,121
Value	$18,022,578	$10,578,895	$18,691,047
Electrolytic process, tons	122,424	75,547	.....
For sale tons	119,123	67,990	.....
Value	$7,033,969	$6,049,505	.....

Caustic soda is used in many industries and for the sake of illustration we will again have recourse to the January, 1926, issue of *Chemical & Metallurgical Engineering* in which distribution was shown as follows:

TABLE II—DISTRIBUTION OF CAUSTIC SODA

Consumed by:	1923 Tons	1924 Tons	1925 Tons
Soap	105,000	100,000	110,000
Chemicals	70,000	60,000	75,000
Lye	55,000	53,000	57,000
Rayon	40,000	35,000	49,500
Other textiles	40,000	34,000	36,000
Petroleum	40,000	50,000	55,000
Vegetable oils	12,000	11,000	14,500
Rubber	8,000	7,000	16,000
Pulp and paper	3,000	5,000	9,000
Storage battery	2,000	3,000	5,000
Miscellaneous	4,000	4,000	15,000
Exports	57,000	46,000	50,000
Totals	436,000	408,000	492,000

A large part of caustic soda production is distributed against contracts. It is customary to announce contract prices for the ensuing year in the early Fall and large consumers, as a rule, cover requirements far ahead. Shipment is made in standard drums. Prices show a range according to quantity—and are on a basis of f.o.b. works but export quotations are on a f.a.s. basis with export shipments in large drums of 700 lb. net. Most producers are represented in consuming centers by dealers who will accept orders for small lots for delivery out of stocks, the price generally being on a delivered basis.

The U. S. Alkali Export Association is prominent in the export trade in caustic soda. About 10 per cent of the production is shipped to foreign markets but it is difficult to maintain a steady overseas trade because of competition from foreign producers. Official returns show that shipments to European markets have been falling off in volume but a fairly steady business is done with South America, and the Far East, especially Japan, has proved to be a fertile field for the American product. In fact, in 1925, Japan was the largest foreign buyer of caustic soda, taking more than 22 per cent of the total exported.

Before the war solid 76 per cent caustic soda was quoted at $1.75 per 100 lb., this figure holding good throughout 1913. In 1917 the price had risen to $10.70 per 100 lb. but since the war, a fairly steady price level has been maintained. The latter has been higher than in pre-war years as was necessary in view of higher producing costs. The contract price for 1926 deliveries was $3.10 per 100 lb.

Growth of Liquid Chlorine

At the annual meeting of the American Electrochemical Society held last month at Chicago, D. A. Pritchard in a paper on the "Economics of Chlorine" stated that in the United States the first commercial delivery of liquefied chlorine in cylinders was made in 1909. In that year the Goldschmidt Detinning Co. of Wyandotte, Mich., shipped the first American fifteen-toon single-tank carload of liquid chlorine to their plant at Carteret, New Jersey. The liquid chlorine business grew slowly but steadily, largely due to the pioneer work of E. D. Kingsley, of the Electro Bleaching Gas Co., in the bleaching of cotton textiles and the treatment of potable water supplies. The estimated yearly capacity of all commercial plants in the United States and Canada in 1925 was approximately 185,000 tons of chlorine gas, and of this capacity approximately 46,000 tons were liquefied. What proportion of the total gas capacity and total liquefying capacity was operated in 1925 is not known, but it is certain that a large proportion of both was not operated. These figures do not include Edgewood Arsenal, Maryland, the United States army plant, with a chlorine gas capacity of 36,500 tons. This plant does not operate and is held in standby condition.

Mr. Pritchard said that the packaging and transportation of liquid chlorine has been brought up to a very high standard. It is transported steadily and with almost complete absence of accident in single unit 15-ton steel tank cars, in multi-unit steel cars, carrying fifteen one-ton tanks, and in steel cylinders of 10, 20, 100, 150 and 2,000 lb. capacity. There are over 300 steel tank cars and 80,000 steel cylinders in use or available. The United States of America shipping regulations are embraced in "I.C.C. Regulations for the Transportation of Explosives and Other Dangerous Articles by Freight and Express and as Baggage, Including Specifications for Shipping Containers, Bureau of Explosives, Pamphlet No. 9, Effective Jan. 1, 1923. The Canadian regulations are modeled on the same regulations. This packaging requires a large capital outlay, and the shippers keep records of every container, and maintain a rigorous inspection prior to filling. These items add measurably to the cost of producing liquid chlorine. The makers are also obliged to maintain an expert service as technical assistance to consumers.

Parr Receives Chandler Award

In recognition of scientific achievement in the study of coal carbonization and other practical aspects of fuel technology

SAMUEL WILSON PARR, professor of applied chemistry at the University of Illinois and eminent authority on the chemistry of coal, was the recipient on April 23, 1926, of the Chandler Medal, which is awarded annually by Columbia University in recognition of outstanding achievement in science. Preceding the award Professor Parr delivered the Chandler lecture, choosing for the subject of his address "The Constitution of Coal with Special Reference to Problems of Carbonization." This was the eighth of a series of lectures for which provision was made in 1910 by the establishment of the Charles Frederick Chandler Foundation in honor of this distinguished pioneer in American chemical industry. Previous lecturers under this foundation were L. H. Baekeland, W. F. Hildebrand, W. R. Whitney, F. Cowland Hopkins, Edgar F. Smith, Robert E. Swain and E. C. Kendall. The honor of presenting the present impression of the medal fell to Dr. Baekeland, the first of the Chandler medalists.

Samuel Wilson Parr

By a remarkable coincidence Professor Parr's lecture was, in effect, a centennial celebration of the first paper on fuel technology published in the United States—a discourse by Marquis Bull presented before the American Philosophical Society, April 7, 1826. The question asked then, which can be summarized in the two words "What fuel?" is just as pertinent today as it was one hundred years ago when the author was daring to predict that some day anthracite from Pennsylvania would be displacing the then standard household fuel—shellbark hickory wood. Professor Parr, carrying the prophecy further, foresaw the day of smokeless fuel when raw coal would no longer be permitted to be wasted under boilers or in the heating plant of the householder.

The mechanical engineering study of combustion, which in the past few decades has made such remarkable contributions to the efficiency of this process, is approaching its limitations and the chemical investigation begins to assume the greater significance. Fundamental studies of the constitution of coal cannot follow the empirical procedures of the usual analytical methods. As a matter of fact, neither the so-called proximate nor the ultimate methods give any remote information concerning the real constitution of coal. The newer forms of study make use of the microscope, by means of which the ultimate forms of vegetal matter are revealed. Also by means of some solvent such as phenol, the coal may be divided into two fundamental types of constituents, the lignitic or non-coking and the bituminic or coking compounds. Other methods which give additional information involve a study of chemical activity and interaction between the component parts.

As a result of studies along this line it is revealed that coals, especially of the mid-continental area, are much more sensitive in their chemical characteristics to alteration than the coking coals of the eastern part of the United States, but by utilizing the information thus attained, it is possible to follow methods of procedure which will conserve these coking constituents and result in a coke of excellent density and strength. Studies of this type on the constitution of coal, therefore, reveal the conditions which must be followed. It may be said further that these conditions suggest what is known as the low temperature type of procedure in preference to the higher temperatures of the standard coking process. It is further of interest to note that by observance of the conditions revealed by these studies it is possible to accomplish a low temperature carbonization in a cross sectional area of from twelve to fourteen inches, instead of the narrower section of five or six inches ordinarily assumed to be necessary. In this connection Professor Parr described the features of the retort and process for the carbonization of Illinois coals which have been developed over a considerable period of years by himself and his associates at the University of Illinois. The coke produced is smokeless and especially adapted to household appliances, while the byproducts are of especial interest because of the fact that under the conditions prescribed a very considerable yield of gas is secured—from four to four and one-half feet per pound of coal. The other main byproduct, the tar, is of interest because of its type and commercial value.

Prof. S. W. Parr was born in Granville, Ill., January 21, 1857. After receiving the degrees of B. S., from the University of Illinois in 1884, and M. S. from Cornell in 1885, he continued his studies in the University of Berlin and at the Polytechnikum in Zurich. During 1885-1890 Parr was an instructor and later professor of general science at Illinois College. In January, 1891, he was given the chair of professor of chemistry at the University of Illinois, which he has held continuously for 35 years.

On the Engineer's Book Shelf

A Bird's-Eye View of the Oil Industry

THE OIL INDUSTRY. By *Ernest R. Lilley*, assistant professor of geology, New York University. D. Van Nostrand Company, New York. 548 pp. Price $6.

Reviewed by S. D. Kirkpatrick

Orientation, according to our pedagogical friends, is the process by which the student takes his bearings before starting out on his educational career. Obviously, this process does not end with the college. Throughout his entire industrial experience the worker must face the problem of orienting himself in relation to his environment and particularly in relation to his job. To the technical man in the petroleum industry—whether he is serving in its production, transportation, refining or marketing divisions—Professor Lilley's book will prove a helpful adjunct in this process of professional orientation.

The oil industry possesses too many ramifications of highly specialized interest to permit a single individual to know, in a detailed way, the work that is being carried on in all of the various divisions. Yet unless the worker has at least a general conception of the problems outside of his own particular sphere of activity, he is severely handicapped. The engineer in the field or in the refinery needs to have the bird's-eye view that only such a book as this can give.

With this purpose in mind the author has prepared an interesting story of all phases of the petroleum industry. The balance he has made between production and refining, for instance, is probably not the one that would have been made by the refinery engineer, yet the book should be all the more valuable to the latter for the wealth of detail given in the dozen chapters that deal with exploration and leasing, field practice and drilling, and the descriptive accounts of the principal oil fields of the world.

The single chapters on natural gasoline production, refining and cracking will doubtless prove disappointing to the reader in search of operating detail or information on the design of refinery equipment. In fact, the reviewer's principal criticism is that there is a noticeable absence here of much of the valuable detail that characterizes the greater proportion of the book.

The chapter on "World Corporation Control" is an intensely interesting history of the development of one of America's greatest industries. It is more of a romance, however, than a history for it carries forward the story of the principal competing companies through the critical period of trial and difficulty that early beset their development. To read this chapter is to get an entirely different view of the American petroleum industry—one that should be helpful not only to the worker within the industry but to the countless number of self-appointed critics outside the industry who have always taken it for granted that mere corporate bigness is ample proof of unethical and unfair business practice.

A Guide Book for Fuel Users

FUELS AND THEIR COMBUSTION. By *Robert T. Haslam* and *Robert P. Russell*, professor and assistant professor respectively of chemical engineering, Massachusetts Institute of Technology. McGraw-Hill Book Company, Inc., New York. 809 pp. Price $7.50.

Reviewed by Graham L. Montgomery

Technical books generally fall in one of two classes: either they are suitable for use as college textbooks; or they are best fitted for use as reference works or guides for men in industry. The present work, although said to be based on a lecture course given at M. I. T., plainly falls into the latter class. Its scope is so very broad and it deals in such a comprehensive way with its subject that it is hard to imagine it used as a text except in a course in which the aim was to prepare combustion specialists.

For the user of fuels, the man in the plant, this book should prove of highest value. It covers the subjects of coal, petroleum, and gaseous fuels completely, their origin, preparation and use being simply but well brought out. The chemical and physical bases of combustion are treated and some 68 pp. devoted to the important topic of combustion calculations. Several long chapters are devoted to furnaces and other combustion devices. Furnace efficiency, heat losses and methods of figuring heat balances are fully treated. Those unit processes of chemical engineering that are closely bound up to combustion—flow of fluids and heat transfer—receive due notice. And finally, although the reason for this inclusion is hardly clear, some 150 pp. are devoted to an account of the manufacture of producer gas, water gas and oil gas, and to the carbonization of coal.

As intimated, this work is a veritable cyclopedia for the fuel user. In addition, the information on the various topics is sound, up-to-date and concise. Much praise is due the authors for the way in which they have gathered their facts together and compiled them. One might wish that credit were always given to the source of such information, as, for instance, on pp. 489 to 491, where the material on costs of fuel oil atomization is taken from *Chem. & Met.*, Feb. 23, 1925, page 323, with no mention of that fact. However, such a slip is a minor fault and, in general, full credit is accorded in the valuable bibliographies printed at the chapter ends or in the text. All things considered, this work appears to be the most useful so far produced for those who use fuels and combustion processes. It is earnestly recommended to their attention.

American Year Book

THE AMERICAN YEAR BOOK. Organized by *The American Year Book Corporation* and edited by *Albert Bushnell Hart* and *William Schuyler*. The Macmillan Company, New York. Price $7.50.

After an interval of seven years, "The American Year Book" has been revived under a guaranty by Mr.

Adolph Ochs of the *New York Times*. The present 1926 volume is much enlarged in scope and in the amount of material. Events of 1925 have been discussed by about 270 authorities, and with the co-operation of 50 professional societies.

Proceedings of the A.S.T.M.

PROCEEDINGS OF THE TWENTY-EIGHTH ANNUAL MEETING, A.S.T.M. Published by American Society for Testing Materials, Philadelphia, Pa. Part I, 962 pp.; Part II, 434 pp. Price, $6 in paper, $6.50 in cloth and $8 in half-leather binding.

Part I contains the annual reports of 35 of the standing committees of the Society, together with the discussion thereon at the annual meeting. They include reports of Committees on Ferrous Metals, Non-Ferrous Metals, Cement, Ceramics, Concrete, Gypsum, Lime, Preservative Coatings, Petroleum Products, Road Materials, Coal and Coke, Waterproofing Materials, Electrical Insulating Materials, Rubber Products, Textile Materials, Thermometers, Metallography, including a report on Metal Radiography and X-ray Crystallography, Methods of Testing and Nomenclature and Definitions and 83 tentative standards which have either been revised or are published for the first time.

Part II contains 26 technical papers with discussion. These contain information on results of investigations by experts in the field of engineering materials, including the fatigue of metals, the effect of temperature on the properties of metals and investigations on the corrosion of metals. Mention should also be made of the many papers on cement and concrete and on the stability of bituminous mixtures as well as on such subjects as bituminous materials, paint, gypsum, brick and textiles.

History and Functions of Government

THE BUREAU OF STANDARDS AND ITS HISTORY, ACTIVITIES AND ORGANIZATION. By *Gustavus A. Weber*. Service Monograph Number 35 of the Institute for Government Research. Published by the Institute for Government Research, Washington, D. C. 300 pp. Price $2.

Reviewed by R. S. McBride

This is the most recent technical volume in an unusual series of monographs describing the history, activities and achievements of the various bureaus and independent offices that comprise the United States Government organization. Already there are 36 of these volumes and more are in preparation. It is the expectation that within a few years there will be one such volume for each bureau or independent establishment, so that the set as a whole will afford a convenient reference source for anyone desiring to learn the details of Federal activities.

This effort through a wholly unofficial agency is not a critical attack upon any present scheme or policy, nor does it have as its purpose the creation or support of any particular phase of government work. The purpose is rather to view from an impartial outside point each government office as a going concern and to present without prejudice the facts as found.

The scope of the works is best described in the foreword of this volume, as this gives an idea of the uniform plan under which all the monographs have been prepared:

"They give: first, the history of the establishment and development of the service; second, its functions, described not in general terms, but by detailing its specific activities; third, its organization for the handling of these activities; fourth, the character of its plant; fifth, a compilation of, or reference to, the laws and regulations governing its operations; sixth, financial statements showing its appropriations, expenditures and other data for a period of years; and finally, a full bibliography of the sources of information, official and private, bearing on the service and its operations."

One who has frequent dealings with any branch of the government service and wishes to have at hand a well-indexed convenient reference work on it can well procure the volume of this series covering that particular bureau or office. Thirty-six of the service monographs are already available and additional numbers are appearing at frequent intervals. The price in each case is nominal, varying from $1 to $2 per copy. The time saved in futile correspondence because of faulty understanding of the government functions of any particular agency will well repay the purchase and use of such a book as this.

A Bibliography on Research

A BIBLIOGRAPHY ON RESEARCH. Selected articles from the technical press in 1923, 1924 and 1925. National Research Council, Division of Engineering and Industrial Research, New York. 46 pp.

Interest in the general topic of research is such that no less than 1,500 major articles have appeared in the technical press in the past 3 years. These have been classified according to branches of science or industry, making the most extensive and usable bibliography on research ever published.

This compilation is commended particularly to those organizations making a start in research, in order that they may become acquainted with the broader aspects of this essential function of modern education and industry.

TRADE STANDARDS ADOPTED BY THE COMPRESSED AIR SOCIETY. Second Edition. Published by The Compressed Air Society, New York. 48 pp.

This pamphlet embodies the result of extended study and research on the part of the executives and engineers associated with the members of the Compressed Air Society and embraces the nomenclature and terminology relating to air compressors and their operation; a history of the development of speeds of air compressors; an explanation of capacities and pressures; instructions for the installation and care of air compressors with illustrations of devices suggested for cleaning the intake air; recommendations for the lubrication of air compressing machines and the cleaning of air receiver piping; a description of the low pressure nozzle test recommended by the Society, and a partial list of applications of compressed air.

Mellor's Inorganic Chemistry

A COMPREHENSIVE TREATISE ON INORGANIC AND THEORETICAL CHEMISTRY (Vol. VI). By *J. W. Mellor*. Longmans, Green and Co., New York. 1024 pp. Price $20.

The sixth volume of Mellor's work comprises a conclusion of the chapter on carbon compounds and a discussion of silicon and its compounds—particularly the natural silicates, the composition and constitution of which have heretofore been the subject of considerable doubt. Readers of previous volumes in the series will not be disappointed in the present book, which in itself is an unusual contribution to the literature.

Recent Articles in Technical Periodical Literature

Advances in Acetone Production by Fermentation. The practical difficulties in the acetone-ethyl alcohol fermentation process have now been overcome, and profitable production on a large scale is possible. The yield is better than in the acetone-butyl alcohol fermentation, amounting to about 40 per cent of the carbohydrates. The product makes an excellent motor fuel. Hydrogen can be recovered as a byproduct. Operating costs are low enough to permit European producers to compete with acetone from America. Stefan Bakonyi, *Chem.-Ztg.*, April 10, pp. 257-8.

Tin Plate for Canning. Porosity in tin plate is chiefly due to hydrogen from the pickling process, occluded in or combined with the surface iron. In tinning, this hydrogen is liberated and forms pores. Oxidation (with peroxides, chromic acid, chlorine or the like) before tinning removes the hydrogen and prevents porosity. Preferred formulas are given for 6 kinds of iron for tin plate. H. Serger, *Chem.-Ztg.*, March 20, pp. 201-2.

Alumina Cement. The quick setting of alumina cement, its mechanical properties and its greater chemical stability give this material important advantages over portland cement. If all factors are considered, it is even safe to say that construction with alumina cement, in spite of the higher first cost, is no more expensive than with portland cement. Hans Eisenbeck, *Chem., Ztg.*, March and April, pp. 165; 202; 239 and 246.

Thermoelectric Pyrometry. A discussion, from the practical standpoint, of the selection, installation, care and calibration of thermocouple pyrometers; illustrated. A. E. R. Westman, *Can. Chem. and Met.*, April, pp. 77-80.

Carbonization of Canadian Fuels—III. Yields of various products by high- and low-temperature carbonization of wood, peat, lignite and bituminous coals are compared. The lowest temperature at which the Canadian bituminous coals could be successfully carbonized was about 400 deg. C. At 500 deg. the oil yield was about the same as at 600 deg. R. E. Gilmore, *Can. Chem. and Met.*, April, pp. 85-7.

Synthesis of Waxes. Studies in the technical conversion of the common fatty acids into ketones, from which the secondary alcohols, olefines and esters found in natural waxes can be made. Mixed wax esters are much easier to make than chemical individuals, and have better properties as waxes. Numerous difficulties were encountered in choice of catalysts and reaction conditions. A. Grun, Ernst Ulbrich and Franz Krczil, *Zeitschr. angew. Chem.*, April 1, pp. 421-8.

Wood Impregnation by the Cobra Process. In the Cobra system, the most exposed part of the timber is bored with numerous small holes several centimeters deep, which are then filled with the solution of dinitrophenol, sodium fluoride or zinc chloride. The less exposed part of the timber is coated with the solution. Illustrated. R. Nowotny, *Zeitschr. angew. Chem.*, April 1, pp. 428-31.

Making Cast Iron of High Strength. The proper chemical composition for strong cast iron has long been known. Difficulties in furnace construction are now being overcome. The best results are being obtained in oil fired cupola furnaces, the necessary Si and Mn being added to the melt from outside. Further progress is expected. C. Gilles, *Zeitschr. angew. Chem.*, April 8, pp. 458-9.

Vinasse as a Nitrogen-Potash Fertilizer. By absorbing vinasse concentration 32-36 deg. Brix) in fossil flour, a friable granular powder is obtained which carries about 1.1 per cent N, 0.35 per cent P_2O_5 and 4.4 per cent K_2O. It is being marketed under the name *Kalinzoto*. Some sugar refineries fertilize their own beet fields with this material. Erco'e Cerasoli. *Giorn. chim. ind. ed appl.*, Feb., pp. 61-2.

Sterlizing Sewage with Chlorine Gas. An installation in Trieste is described and illustrated. Methane is recovered from the Emscher tanks in which the sewage is treated. The method is more economical and convenient, and also safer, than the chloride of lime treatment. Mario Cambon, *Giorn. chim. ind. ed appl.*, Feb., pp. 63-7.

Recent Studies of Porcelain. Crystalline quartz is less desirable in porcelain mixes than flint or quartz sand, from the standpoint of mechanical and electrical properties. Other topics discussed include: ceramic pigments and glazes; firing behavior of koalin and other clays; raw materials and their common impurities. E. E. Urbschat, *Zeits. angew. Chem.*, March 18, pp. 364-8.

Converting Cl_2 to HCl with Steam in Presence of C. An excellent yield of pure HCl can be obtained by treating Cl_2 with steam at about 350-400 deg. in presence of wood charcoal containing Fe oxide. The liberated O_2 unites with the C, and CO_2 is obtained as a byproduct. This process thus makes unnecessary the use of water gas or other oxygen-fixing agent. B. Neumann and R. Domke, *Zeits. angew. Chem.*, March 18, pp. 368-74.

Converting Br_2 to HBr with Steam in Presence of C. The same process as for chlorine (preceding item) can be applied to bromine at about 500 deg. By suitable regulation of the excess steam, pure fuming HBr can be made in this way in concentrations up to 60 per cent. B. Neumann, W. Steuer and R. Domke, *Zeits. angew. Chem.*, March 18, pp. 374-5.

Cellulose Lacquers. Acetate and nitrocellulose lacquers; solvents, plasticizers and pigments; manufacture of finished lacquers and their application to fabrics, metal, wood, glass and to such uses as electric insulation, artificial jewelry and ornaments, etc. L. Clement and C. Riviere, *Rev. gen. mat. plastiques*, March, pp. 175-9.

Some Aspects of Wood Distillation. Although the situation is serious in the wood products industry, it is improbable that synthetic materials will drive wood products off the market. By proper attention to byproducts, such as activated charcoal, efficient production of acetic acid and methanol on a comparative basis should be possible. Technical details, such as methods of improving the yield or operating efficiency, should be thoroughly studied. Jacques Mauger, *Chim. et Ind.*, March, pp. 474-8.

Temper Colors and Other Tints on Metals. Invisible films of oxide or other compound on metal surfaces give rise to interference phenomena which cause the play of color often seen in working metals. Ulick R. Evans, *J. Soc. Chem. Ind.*, March 26, pp. 211-5.

Theory of Steam Deodorization of Saponifiable Oils. The most important factors for rapid deodorization are low pressure in the deodorizer and high temperature in the oil. Equations are given for temperature of the entering steam, for concentration of volatile matter at any moment, and for calculating dimensions of the apparatus and form of the outlet pipe. W. Brash, *J. Soc. Chem. Ind.*, March 26, pp. 73-5T.

Phosphorus in Agriculture. Superphosphate is best for quick crops on limed land; basic slag is best for grass land. Sour soils are slower to take up phosphate than limed soils. The principal regions where land is phosphorus poor are Canada and the U. S. (due to working farms with insufficient fertilizer) and South Africa (natural deficiency). Ernest Vanstone, *J. Soc. Chem. Ind.*, March 26, pp. 78-80T.

Thiocarbonyl Chloride in Synthesis of Organic Sulphur Compounds. Substituted aromatic thiocarbimides and thiocarbamides can be made, with good yields, from thiocarbonyl chloride and the substituted aromatic amines, such as toluidines, xylidines, etc. The cost of the thiocarbonyl chloride is not excessive, provided the tin liquors from the reduction plant are recovered; and the difficulties due to its odor and toxicity can be obviated. Geo. M. Dyson and R. F. Hunter, *J. Soc. Chem. Ind.*, March 26, pp. 81-5T.

Anti-Knock Compounds. Iron carbonyl is being exploited in Germany (the Badische Co.) as an anti-knock. It has the same disadvantages as tetraethyl lead, of being toxic and giving a solid residue. Research will doubtless bring out a more satisfactory compound. Toluidine and ethyl sulphate, both of which have received considerable attention, are relatively ineffective. Dumanois *Bull. de la Soc. de Chim. Ind.*, Jan.-Feb.-March, pp. 5-7.

Coke-Oven Ammonia. The great economic advantages of establishing synthetic ammonia units at coke-producing plants can now be successfully realized. A process has been worked out for large scale separation of hydrogen from coke-oven gas by partial liquefaction. The available hydrogen being in excess of the amount needed for ammonia, the nitrogen can be cheaply obtained by burning surplus hydrogen in air. Illustrated. Georges Claud . *Compt. rend. de l'Acad. des Sciences*, April 7, pp. 877-81.

Some Notes on Kimmeridge Shale Oil. This oil contains a large proportion of sulphur in a form not amenable to the usual chemical treatments. Laboratory trials indicate, however, that the sulphur can be satisfactorily removed by suitable distillation. The ash from this shale makes an excellent base for fertilizer and should be worth

about $10 per ton. J. Stewart Remington, *Ind. Chemist*, April, pp. 150-2.

Electrical Precipitation in Chemical Industry. Some Lodge-Cottrell installations are described and illustrated, as used in tin smelting, at blast furnaces, and in making portland cement. H. W. C. Henderson, *Ind. Chemist*, April, pp. 161-5.

Lithopone Industry. Manufacture, properties, analysis and specifications for lithopone; uses in paint, rubber and linoleum. N. F. Budgen, *Ind. Chemist*, April, pp. 169-72.

Dangerous Chemicals. Safe packing, storage, use and transport of dangerous liquids including volatile, flammable and explosive solvents and fuels, and corrosive or toxic liquids such as acids, caustic solutions, halogens and halides as such or in solution, etc. British Government regulations are discussed. H. Joshua Phillips, *Ind. Chemist*, April, pp. 173-6.

Materials of Construction. The use of cast iron and acid-resistant enamel in the construction of plant equipment. B. Liebing, *Apparatebau*, 1926, vol. 38, pp. 61-3; 73-4. Also: Acid Resistant Iron. Th. Hoffman, *Chem. Apparatur*, 1926, vol. 13, pp. 69-70.

Welding. Scientific basis of electric arc welding. (Cont.) H. Neese, *Apparatebau*, 1926, vol. 38, pp. 64-6; 75-9.

Synthetic Petroleum. Synthesis of petroleum from water gas at atmospheric pressure. F. Fischer and H. Tropsch, *Brennstoff-Chemie*, 1926, vol. 7, pp. 97-104.

Coal. Review of the report of the "Royal Commission on the Coal Industry." R. Lessing, *Chem. & Ind.*, 1926, vol. 45, pp. 196-9.

Hydration of Coal. Investigations on the Bergius process for hydration of coal. (Cont.) M. Heyn and H. Dunkel, *Brennstoff-Chemie*, 1926, vol. 7, pp. 81-7.

Fuel. Carbonization of Canadian fuels. (Cont.). R. E. Gilmore, *Canad. Chem. & Met.*, 1926, vol. 10, pp. 85-7.

Flue Gases. A discussion of how to secure efficient draft for the disposal of flue gases. P. H. Parr, *Int. Sugar Journ.*, 1926, vol. 28, pp. 80-3.

Heat Economy. Heat economy in the chemical plant. Dr. Blaschke. *Chem. Ztg.*, 1926, vol. 50, pp. 189-91; 226-7.

Government Publications

Prices indicated are charged by Superintendent of Documents, Washington, D. C., for pamphlets. Send cash or money order; stamps and personal checks not accepted.

Specification for Shellac, Flake Orange. Bureau of Standards Circular 302. 5 cents.

Fire-Clay Brick, Their Manufacture, Properties, Uses and Specifications. Bureau of Standards Circular 282. 25 cents.

A Photometric Method for Measuring the Hiding Power of Paints, by H. D. Bruce. Bureau of Standards Technologic Paper 306. 10 cents.

Durability of Cement Drain Tile and Concrete in Alkali Soils: Fourth Progress Report (1923), by C. M. Williams and Irving Furlong. Bureau of Standards Technologic Paper 307. 20 cents.

Cement-Lime Mortars, by H. V. Johnson. Bureau of Standards Technologic Paper 308. 15 cents.

Behavior of Synthetic Tanning Materials toward Hide Substance, by Edward Wolesensky. Bureau of Standards Technologic Paper 309. 5 cents.

Forestry and Forest Products. A statistical statement for 1924 compiled by the Forest Service. U. S. Department of Agriculture Separate from Yearbook 1924 No. 910. 5 cents.

Chemistry and Analysis of the Permitted Coal-Tar Food Dyes, by Joseph A. Ambler, W. F. Clarke, O. L. Evenson, H. Wales. Department of Agriculture Department Bulletin 1390. 10 cents.

Oil Pollution of Navigable Waters, by an Interdepartmental Committee reporting to the Secretary of State. 20 cents.

Census of Dyes and Other Synthetic Organic Chemicals. Preliminary Report of the U. S. Tariff Commission. Press statement.

Additions, Removals and Changes in Permissible List of Explosives from January 1, 1925, to December 31, 1925, by C. St. J. Perrott. Bureau of Mines Serial No. 2737.

Gases from Blasting in Heavy Sulphides, by E. D. Gardner, G. W. Jones, and J. D. Sullivan. Bureau of Mines Serial No. 2739.

Thirteenth Semi-Annual Motor Gasoline Survey, by E. C. Lane, H. M. Thorne, and John Devine. Bureau of Mines Serial No. 2740.

The Effect of Phosphorus on the Resistance of Low-Carbon Steel to Repeated Alternating Stresses, by F. F. McIntosh and Wayne L. Cockrell. Bulletin 25, Carnegie Institute of Technology, reporting co-operative study with the U. S. Bureau of Mines. Price 50 cents, available only from Carnegie Institute, Pittsburgh.

Beneficiation and Utilization of Georgia Clays, by R. T. Stull and G. A. Bole. Bureau of Mines Bulletin 252. 20 cents.

Possibilities for the Commercial Utilization of Peat, by W. W. Odell and O. P. Hood. Bureau of Mines Bulletin 253. 35 cents.

Mineral Production Statistics for 1924—Separate pamphlets from Bureau of Mines on: Asbestos; Abrasive Materials; Gypsum; Sand and Gravel; Zinc; Stone; Barytes and Barium Products; Natural-Gas Gasoline; and Natural Gas.

Mineral Statistics for 1925—Preliminary estimates in mimeographed form from Bureau of Mines on: Potash; Pyrites; Aluminum Salts; Bauxite; Magnesium Salts; Magnesium; Slab and Rolled Zinc; and Refined Platinum and Allied Metals.

New Process for Making Betaine Hydrochloride

Recently, a novel process of manufacturing betaine hydrochloride and glutamic acid has been developed by a multiple industrial fellowship of Mellon Institute of Industrial Research, University of Pittsburgh. The construction of a factory for the production of these substances is planned by the fellowship donor. The proposed plant will produce 500,000 lb. of betaine hydrochloride annually.

Heretofore this hydrochloride has been available only at a very high price, and consequently the use of it has been limited. Unique properties make it especially desirable for certain therapeutic purposes. Physiologically betaine is an inert, tasteless substance which has been proved to be without deleterious action on the human system. Betaine hydrochloride is a colorless, easily crystalline solid which, upon solution in water, liberates hydrochloric acid by hydrolysis. Thus it may be considered as a solid form of hydrochloric acid which may be taken in tablets without any harmful action on the teeth. For this purpose it has been sold under the pharmaceutical name "acidol."

Another important use of this acid is as a substitute for tartaric acid in the preparation of effervescent salts of all sorts. It is especially valuable in preparations in which tartaric acid is objectionable.

Betaine hydrochloride is also a potential source of trimethylamine and other methyl amines. A good yield of trimethylamine may be obtained from it simply by treatment with alkalies.

The investigations concerning the properties and uses of this interesting acid are being continued at Mellon Institute and doubtless will disclose other commercial applications of the substance.

Unpublished Directions for Organic Syntheses

The editors of "Organic Syntheses," an annual publication of satisfactory methods for the preparation of organic chemicals, now have at hand a large number of preparations in addition to those to be included in vol. 6, which is now in press, and in vol. 7, which will soon go to the printer. The following is a partial list of these preparations. Chemists interested in any of these preparations can procure copies from Frank C. Whitmore, Northwestern University, Evanston, Illinois.

Graduate Courses at University of Michigan

Bulletin No. 31, vol. 27 of the University of Michigan outlines the program in chemical engineering and graduate courses in general chemical engineering, metallurgical engineering, gas engineering and organic chemical industries. General information about the University, facilities for instruction and research, academic requirements and publications of the chemical engineering faculty also are described. Inquiries regarding the above courses should be addressed to Department of Chemical Engineering, Room 2028, East Engineering Building, Ann Arbor, Mich.

Mellon Institute Publications

The Mellon Institute of Industrial Research of the University of Pittsburgh has published the Fourth Supplement to Bulletin No. 1 of the Bibliographic Series, being a list of the bulletins, contributions to the periodical literature, and patents by Institute members during the calendar year 1925. Copies of the bulletin will be sent gratis upon application to the Institute.

The Plant Notebook

An Exchange for Operating Men

Using a Locomotive for A Boiler Plant

An interesting expedient was recently employed by the Pharis Tire & Rubber Company, Newark, Ohio, when one of their boilers failed. In order to supply the additional amount of steam necessary to keep the plant in full operation until the disabled boiler could be replaced, an ordinary type of switch locomotive was secured from a nearby railway. This locomotive was run onto the coal track next to the boiler plant and its boiler was connected by means of a pipe from the steam dome to the steam main in the boiler house. As a method of supplying an emergency demand for steam this expedient seems to have many possibilities.

Preventing Corrosion With Protective Coatings

By Thomas W. Hind
New York, N. Y.

There is no cure-all for corrosion, but certain protective measures will prolong the life of property and equipment to a considerable extent. It is possible to reduce waste in some cases of corrosion in a large degree by the application of protective coatings.

One of the types of these coatings that has given good results against corrosion by water, electrolysis, acids and alkalis is that having a bitumen base. The raw materials for such a coating contains various percentages of impurities that produce hardness and brittleness. These impurities must first be removed and the soft and pliable portion then made into a solution. If the coating is to be used as an enamel it must be further treated to give it qualities such as are described in the U. S. Navy Specifications 52-B-10 of January 3, 1922. Such treatments prevent cracking or breaking under contraction or expansion and also under shock similar to that encountered in filling bins or bunkers.

The selection of a suitable solvent for making such a coating is important. None of the commercial solvents in customary use are satisfactory and in compounding a suitable thinner it is necessary to blend several solvents in which the gravity, purity and amount used of each plays an important part in the making of the coating.

In applying these coatings either hot or cold, it is essential that the surfaces to which they are applied first be cleaned either by sand blasting, chipping or with a wire brush. All old paint and dirt or rust must be removed. After this the solution may be either brushed or sprayed on.

The uses for such coatings are numerous. For instance, concrete is readily attacked in certain places and in cases where reinforced concrete is exposed to dampness, the reinforcement members are liable to corrosion. Coating of the reinforcing bars before the concrete is placed around them will prevent this corrosion. Also a double coating of such a solution on the outside of concrete enables it to withstand such corrosion as occurs in sugar refineries where the floors are subjected to strong sweet water solutions.

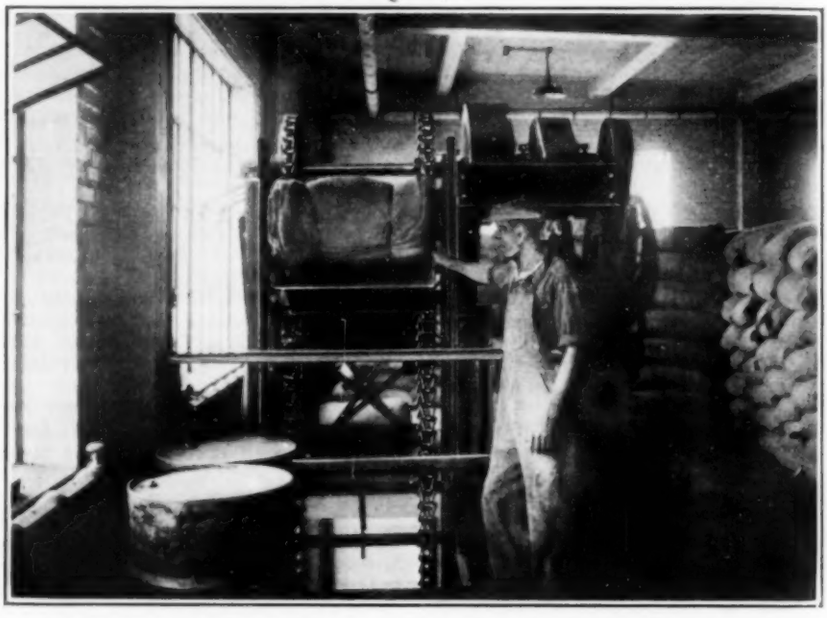
Terra cotta sewage tile is often exposed to corrosion from waste chemical solutions contained in the sewage. This corrosion occurs at the joints where the bond has been made with some sort of cement. These joints can be made to resist the action of corrosive materials by using either a plastic coal tar or asphalt paint, or by running them in with a molten compound of asphalt or mineral rubber.

As mentioned by Hauser and Buhlan (*Chem. & Met.*, Vol. 28, p. 159) woods are best preserved in many conditions by giving them protective coatings of coal tar and asphalt enamels.

Caustic alkalis attack and destroy all paints and varnishes by dissolving the resins. However, coatings made with coal tar and asphalt bases are not affected in this manner and can be used for the protection of equipment subject to alkali corrosion.

Bureau of Standards Circular Letter No. 42, revised, covers the protection of concrete floors, vats, tanks, reservoirs and other concrete surfaces against mineral acids and acid salts. The method recommended depends upon the application, the strength and temperature of the acid, and whether the coatings must withstand abrasion. The coatings recommended are of bituminous composition.

Where it is desired to have some other coating-color than black in the coating, it is advisable to first apply a black bituminous coating of the type described above. Colored coatings made with a bituminous base can be obtained in a number of different shades and when these are applied over a first coat of black solution, the color will hold.



Top or Discharge End of Tray Elevator Showing How Empty Bags Are Returned on Reverse Side of Trays

Cutting Car Unloading Costs With a Tray Elevator

The car unloading methods of the Tropical Paint & Oil Company of Cleveland, Ohio, have recently been revamped with a result that is said to save 40 per cent of the cost of unloading cars of long fiber asbestos.

This material is received in large but light-weight bags. It was formerly unloaded by being carried from the cars to a freight elevator, which took the bags to the top floor of the plant where the storage space is located.

The new method makes use of a Stearns tray elevator, consisting of a double chain, motor driven conveyor, in an appropriate frame with trays suspended between the chains. These trays are designed to accommodate bags or barrels. The car is spotted directly at the elevator. The bags are loaded on the trays and conveyed to the upper story, where an automatic

discharging device tilts each tray in succession and allows its load to slide off onto a sloping table. From this table, it is slid onto a hand truck and trucked to the storage space, as shown in the illustration.

The superintendent of the plant states that this method decreases the unloading time 2 hours per car, which is about 40 per cent of the time formerly required. It also saves possible delays in production and possible demurrage charges. The same number of men—6 in all—are now used as before, so that the saving made equals 12 man-hours per car.

Avoiding Hazard in Handling Caustic Soda

Most caustic soda is handled as solid caustic. This caustic is shipped in drums containing one solid mass of the material weighing 700 lb. In removing the caustic from the drums and performing other handling operation, workers should wear goggles and rubber gloves. Special clothing that offers minimum opportunity for lodgement of caustic chips or dust should be used. A handy supply of clean water should be available. Means for washing out the eyes with ½ of 1 per cent solution of acetic acid should be provided. These precautions are necessary because minute quantities of caustic soda cause painful burns, particularly of the eyes.

Turbine Drive for Pumps Makes Saving

It is reported by the General Electric Company that a 60-hp., Style D-51, two-stage turbine driven centrifugal pump installed by them in Findlay, Ohio, for the Toledo, Bowling Green & Southern Traction Company has effected an annual saving of $663.75 which is a return of 28.9 per cent on the investment.

This pump has replaced two previously installed pumps that are now used as a stand-by. The new unit has 50 per cent greater capacity than the two previous pumps but occupies only one-fourth the floor space. Its water rate is 20 per cent less than the water rate of the duplex pumps. It has so far required no repairs compared to an average expenditure of $235 per year on the former installation. Attendance has been cut down four-fifths and oil consumption has been cut from one gallon per day to one-half gallon per month.

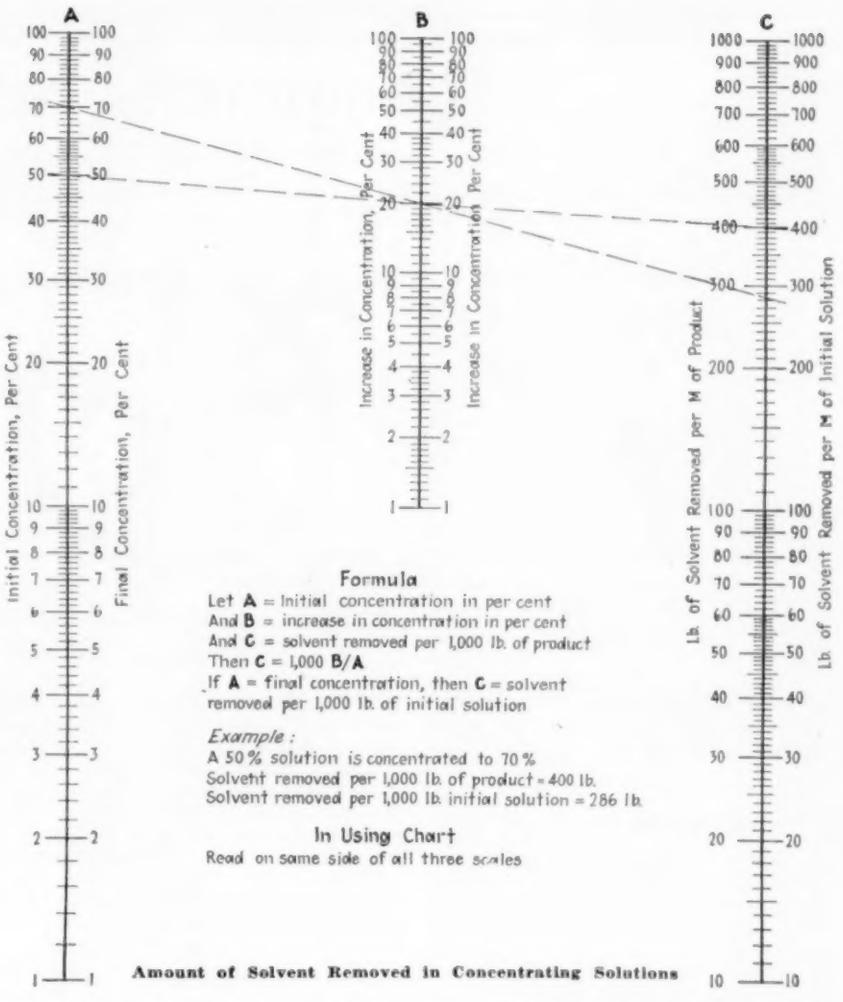
The above advantages obtained suggests that many plants could undoubtedly save money by bringing obsolete pumping installations up-to-date.

Welded Fabrication Makes Leakproof Cooler

A large petroleum refinery has found by trial that welded coolers do not leak and that they also have the advantage of being cheaper in first cost. This refinery made all-welded coolers from 2 and 3 inch standard pipe by the oxy-acetylene welding process.

The first step was to jacket lengths of 2 inch pipe with 3 inch pipe, the ends of the latter being heated and hammered down to a snug fit around the 2 inch pipe. The joints were then welded. The projecting ends of the 2 inch pipe were mitred with a cutting blowpipe and connections of the same size welded between them to form a continuous coil. Finally the jackets were connected in series by welding sections of 2 inch pipe into holes cut for the purpose 4 inches from their ends.

Coolers with flanged connections cost the refinery $250.00 each plus freight. The coolers fabricated by welding cost $165.00 each, a saving of $85.00 per cooler. The welded coolers develop no leaks when tested under a pressure much higher than the ordinary working pressure required.


A
B
C
Initial Concentration, Per Cent
Final Concentration, Per Cent
Increase in Concentration, Per Cent
Increase in Concentration, Per Cent
Lb. of Solvent Removed per M of Product
Lb. of Solvent Removed per M of Initial Solution
Formula
Let A = Initial concentration in per cent
And B = increase in concentration in per cent
And C = solvent removed per 1,000 lb. of product
Then C = 1,000 B/A
If A = final concentration, then C = solvent removed per 1,000 lb. of initial solution
Example:
A 50% solution is concentrated to 70%
Solvent removed per 1,000 lb. of product = 400 lb.
Solvent removed per 1,000 lb. initial solution = 286 lb.
In Using Chart
Read on same side of all three scales

Amount of Solvent Removed in Concentrating Solutions

How Much Solvent is Removed in Concentrating Solutions?

By Samuel Cottrell
Allentown, Pa.

In estimating the cost of various concentrating operations, it is often convenient to know the amount of solvent to be removed per thousand pounds of the initial solution, or per thousand pounds of finished product. The repeated calculation of these amounts, while in no way difficult, may be avoided by the use of the accompanying nomograph.

The chart is based on the formula $C = 1000B/A$, where C is the amount of solvent removed per thousand pounds of finished product, A is the initial concentration of the solution, and B is the increase in concentration. If, however, A is taken as the final concentration, then C becomes the amount of solvent removed per thousand pounds of initial solution. In this chart A and B are expressed as per cents and C as pounds per thousand pounds, and are read on scales A, B and C of the chart respectively. It will be noticed that quantities should be read on the same side of all three scales. Thus, in the examples given on the chart, in concentrating a 50 per cent solution to 70 per cent the solvent to be removed is 400 lb. per thousand pounds of finished product, reading on the left side of the scales, or 286 lb. per thousand pounds of initial solution, reading on the right side of the scales.

Any means of expressing the concentration or units of weight may be used on this chart, provided they bear a linear relation to the percentage and pound units, or are multiples or submultiples of them. Any other relation between the units would require a differently constructed chart.

The scales may be enlarged to give any required degree of accuracy, or if it is found that only a limited range of the chart is required for certain operations, that portion of the chart may be enlarged and used alone.

A line scratched on a celluloid triangle or rule is a very satisfactory device for reading the chart.

Equipment News

From Maker and User

Welding Preheater

An oil burner for preheating large castings prior to welding them has recently been placed on the market by the Alexander Milburn Co., Baltimore, Md. This burner is of the atomizing type and is designed to burn crude oil, fuel oil, kerosene or distillate. It is designed to operate with compressed air under pressures varying from 50 to 100 lb.

This air supply serves two purposes. While furnishing a correct flow of air to the burner, it also maintains a similar pressure on the oil storage tank thus creating a greater velocity in the oil feed line and insuring a uniform flow of oil.

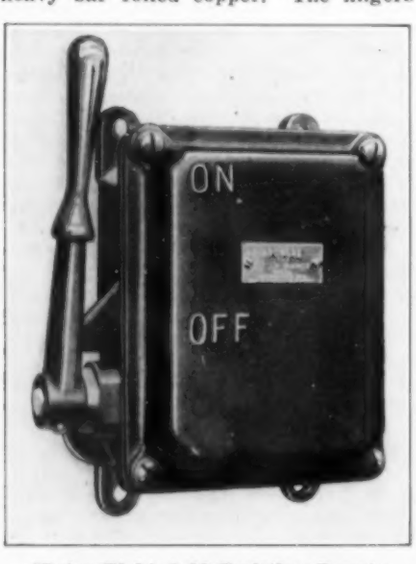
The burner and oil supply tank are designed for portability so that they can be taken to the work in the case of castings too large to be handled.

Remote Control

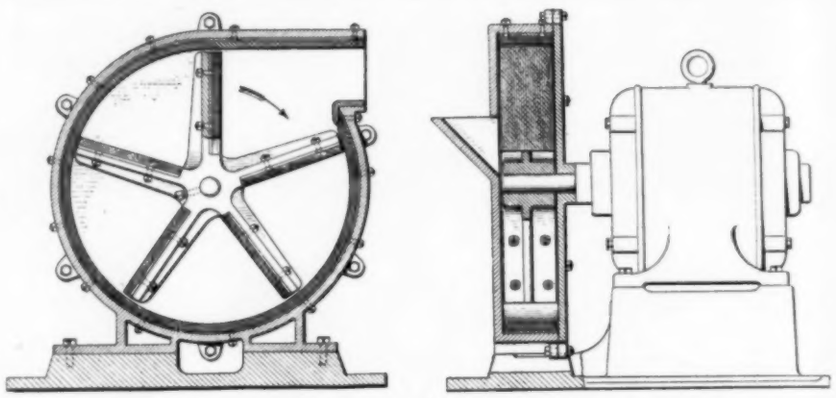
A water-tight, acid resisting remote control station has been developed recently by the Cutler-Hammer Mfg. Co., Milwaukee, Wis. In this device the mechanism is inclosed in a cast-iron case which has a cover fitted with a gasket, designed to exclude all moisture and fumes. A stuffing gland fitted to the shaft provides a tight fit and the wall of the case is sufficiently thick to allow enough threads for a tight conduit or a tight connection.

In the mechanism contact is made on a brass cylinder by two heavy fingers of standard non-stubbing design. These fingers are mounted on asbestos lumber and are zinc plated as are all other small parts. The contact tips are of heavy bar rolled copper. The fingers are of sufficient capacity to permit the use of this master control station on any pilot circuit at all commercial voltages.

As can be seen in the accompanying illustration, operation is by means of a large polished brass handle which extends far enough from the case to indicate whether the station is opened or closed. The exterior of the case is covered with a corrosion resisting coating sufficient to withstand submersion in water or the effect of acid fumes.



Water Right Acid Resisting Remote Control Station



Longitudinal and Transverse Sections of New Impact Pulverizer

Gas-Engine Compressors

The Worthington Pump & Machinery Corporation, 111 Broadway, New York City, has developed a tail rod construction for its small four-cycle double-acting gas engine compressors. This construction serves the purpose of relieving the weight of the piston on the cylinder bore and also allows greater and more effective circulation of the cooling water through the piston and rod.

Worm Reduction Gears

For use with worm reduction gears running at high speed or transmitting high power, the De Laval Steam Turbine Co., Trenton, N. J. has devised a system of forced feed lubrication. In this system the worm threads are supplied by sprays of oil and all of the bearings receive oil under pressure in such a way as to insure complete lubrication and continual circulation of the oil supplied. The oil is drawn through a large bronze strainer located some distance above the bottom of the oil reservoir by a pump which delivers it through passages in the casing to spray nozzles located on both sides of the worm and also to all bearings. The oil passages are arranged to be easily cleaned and the spray nozzles can be taken out for cleaning without disturbing the oil pipes. When it is desirable, an oil cooling system can be connected into this lubricating system.

Impact Pulverizer

The Patterson Foundry & Machine Co., East Liverpool, Ohio, has recently introduced a new impact pulverizer. The novel features of this machine include the elimination of bearings on the pulverizer proper, together with the shaft upon which the rotor was formerly mounted and the elimination of necessity for flexible couplings in connecting to the driving motor, the mounting of the motor shaft, the provision of a resilient lining for the casing, and of resilient facing for the blades.

It is said that the elimination of bearings and the change in the method of mounting have reduced the operating load by one-third and that the replacement of the usual iron or steel lining with a soft rubber lining and soft rubber faces on the blades has reduced wear on these parts about 90 per cent.

In the accompanying view are shown longitudinal and transverse sections of the machine, from which its construction is clear.

Roller Bearing Pulley

A loose pulley fitted with Timken roller bearings has recently been placed on the market by the Dodge Mfg. Corporation, Mishawaka, Ind. This pulley is available in both iron and steel and in addition to the use of the new type of bearing, has other new features.

The steel pulley is of the Oneida type, but is provided with an extra large bore to accommodate the roller bearing unit mounting. The pulley is not split but is riveted at the rim, the clamp hub holding the unit mounting in place. The iron pulley is a standard solid iron pulley similarly fitted for the roller bearing.

In both these pulleys a lubricating pipe is located between the arms at a conveniently accessible point and inserted through a hole bored in the hub. The unit bearing mounting consists of two Timken tapered roller bearings

mounted on a ground steel tube and fitted to an accurately machined cast iron housing. Grease seals and two clamping collars are mounted on the threaded ends of the steel tube. The tube is slotted and threaded at each end and is held to the shaft by two collars which are used to obtain adjustment of the tube. The grease seals prevent dust from getting into the bearing or lubricant from getting out. These pulleys are available in all the standardized bores with unit mountings to fit standard shaft sizes.

Tile and Concrete Construction

A type of construction developed for chimney work that is finding a wide application in other structures used by plants in the chemical engineering industries is the Wiederholdt system used by the Wiederholdt Construction Co., St. Louis, Mo. This has been used in erecting cooling towers, storage bins and silos, as well as for stacks.

The structures are in reality of reinforced concrete; but are unique in that the concrete is poured in permanent tile molds. The first operation is to construct a reinforced concrete mat or foundation from which steel anchor bars extend upward for the purpose of anchoring the superstructure to it. The tile, of hard burned clay and shaped to make circles of varying radii, are then laid as ordinary hollow tile would be. Within the tile are placed the reinforcing rods and the concrete is then poured. The result is a monolithic structure of reinforced concrete with interior and exterior surfaces of tile.

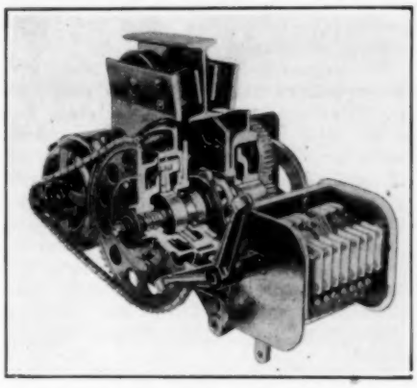
Thirty-Two Day Recorder

An instrument for the purpose of recording temperature variations over a long period of time without demanding any attention has been developed by the Recording Thermometer Co., 654 Mill Street, Los Angeles, Cal. This recorder so far has been used largely in connection with the storage of perishable commodities, but is susceptible of adaptation to many other uses.

The device is made entirely of metal, being housed in a pressed metal case and having an inner frame of pressed metal and a removable metal cover. The metal used is a corrosion resistant alloy which can be exposed to acid, alkali or moisture without damage.

The element of this thermometer is of the bi-metallic type. There is a spring motor with jeweled bearings which is sufficient to operate the recording tape and the pen over a period of thirty-two days. Special paper is provided for the record, of waterproof, non-shrinkable and non-expanding type. This record paper is ruled with curved lines for each two-hour period with straight lines in the other direction indicating each two degree variation of temperature. Along one margin of the paper is printed the number of days elapsed since the record started, so arranged as to be exposed when the instrument is opened to be read.

A special container is made for this instrument by means of which moisture can be totally excluded.



Sectional View of New Ball Bearing Chain Hoist

Electric Hoist

The Yale & Towne Mfg. Co., Stamford, Conn., has recently developed a ball bearing electric chain hoist, called Model 20-B. Among the advantages claimed for this hoist are close headroom, long lift-speed, automatic top and bottom limit stops and increased over-all strength.

The hoist is designed to be quickly adapted to any overhead system. The side plates of the trolley carriage can be placed on steel bars to fit the desired beam flanges. The mechanism is fully inclosed in an oil-tight chamber, but is so arranged as to be readily accessible for inspection.

One of the new developments on this hoist is the use of ball bearings in the load sheave. It is claimed that this innovation greatly lowers the power consumption and increases the over-all efficiency of the device.

Steel chain containers can be furnished with this hoist to hold any length of slack chain up to 60 ft. for the ¼, ½ and 1 ton sizes and 30 ft. for the 2-ton size. These containers are secured to the underframe of the hoist and do not effect the headroom.

Thread Protector

It has been customary in shipping threaded pipe, tube or conduit to supply a coupling on one end of each threaded piece. This protects the thread on that end, but the thread on the other end is exposed to damage.

A device which is said to overcome this trouble at a low cost is the Thread Protector, recently brought out by the Wedge Thread Protector Co., of Cleveland, Ohio. This device consists of a metal cap which is slightly tapered, and which has a shoulder to protect the first thread, and a depression running all around the inner end, so formed that it cannot be shaken loose.

In use, a paper cushion is first placed over the end of the pipe and the metal cap is then driven over the end, either by a blow of the open hand or from a mallet. Although easily applied it is said that the protector cannot be jarred off. It can, however, be easily removed by giving it a half-turn with a wrench.

Another advantage of this device is said to be the fact that when it is used pipe can be stored vertically on end without damage to the thread, thus saving much storage space.

Plunger Pump

A plunger pump for chemical service has recently been placed on the market by the Hills-McCanna Co., 2025 Elston Ave., Chicago, Ill. This pump is designed for delivering liquid against pressure in measured quantities over a determined period.

The standard unit has a ¾-in. diameter piston and the stroke can be regulated from zero to 3½ in. by the adjustment of an eccentric arm. A plug for relieving air binding is provided in the pump body. Ball check valves are also provided attached to the inlet and delivery of the pump.

This pump is provided with a base plate fitted with a beaded edge to take care of any spillage that may occur. Bolt holes for mounting are provided in this base plate. The pump can be operated by means of a driving chain, by motor-drive through reduction gears or by direct connection to reciprocating apparatus.

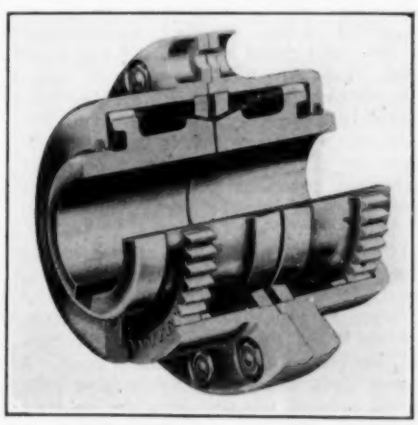
This device is made in cast iron and steel for handling such liquids as sodium aluminate, boiler compound, caustic soda and various water treatments. For handling corrosive chemicals the construction is of various corrosion resisting non-ferrous alloys as may be demanded for the particular service in view.

Flexible Coupling

The Poole Engineering & Machine Co., Baltimore, Maryland, have recently placed on the market a flexible coupling of novel design. This coupling, shown in section in the accompanying illustration, consists of six parts: 2 hubs having an external gear on each, 2 sleeves each having an internal gear for meshing with the gears on the hubs, and 2 aligning rings that are fitted in the sleeves.

The outer faces of the teeth on the hubs are formed spherically to provide a self-aligning bearing for the sleeve. In the case of shafts out of alignment the sleeve assumes a neutral position with a properly formed and lubricated bearing on the spherical surface of each shaft hub.

Lubrication is by oil holes provided in one side of the coupling flange, into which oil should be poured until it runs around the shaft hub. When the coupling is in operation the oil spreads under centrifugal force until the sleeve bear-



Sectional View of Flexible Coupling

ings and gear teeth are entirely submerged, insuring positive lubrication.

Any good grade of machine lubricating oil can be used.

These couplings are available in horsepower capacities from 10½ to 5,350, at maximum speeds respectively from 13,000 to 2,400 r.p.m. Shaft sizes from 1¼ in. in diameter to 12 in. in diameter can be accommodated.

Among the advantages claimed for this coupling are the following: it is all-metal, it is thoroughly lubricated, it is self-aligning without binding action at any point, it is stronger than the shafts to which it is affixed, and it is completely protected on the interior from dust and dirt.

Pressure Water Filter

A new design of pressure filter has been brought out by the Cochrane Corporation, Philadelphia, Pa. In this filter, strainer heads and collecting manifolds have been eliminated. Uniform distribution of the flow throughout the sand layer when filtering and uniform distribution of flow in backwashing, together with a gradual reduction in water velocity from the bottom toward the top of the filter layers when backwashing have been secured by the shape of the filter shell. The methode of withdrawing the water also avoids the possibility of sand passing out through the filter.

The top layer of sand in this filter is of the same character and depth as is usual in pressure filters and the filtering rate is figured on the same basis, that is, 2 to 5 gal. per sq.ft. per minute. The shell is cylindrical throughout the depth occupied by the filtering sand but below this is converging or conical. Underneath the layer of fine sand are 2 layers of gravel and beneath them a layer of pebbles. Imbedded in the pebbles is an inverted open cone from the apex of which the water is withdrawn through a pipe. The pebbles do not extend up into this cone, which is so proportioned that the velocity of the water at the plane where it leaves the pebbles is not great enough to lift or carry out sand particles.

The velocity of the water through the gravel layer and through the pebbles is, however, higher than through the sand bed, and in backwashing all materials are lifted and semi-suspended in the up-flowing water, so that they are resorted and stratified, the finer particles being carried upward and the finest deposited on top. There is no tendency to lift sand from the top of the sand layer, as the velocity is not high enough, even at backwashing rates considerably exceeding 10 to 12 gal. per sq.ft. per minute, which is usually sufficient for taking out sediment or other materials previously deposited in the sand layer during the normal operation of filtering.

The filter is piped up for use either singly or in multiple. The filter is regularly supplied with an orifice and differential pressure gage for measuring the rate of backwashing. Where the backwashing connection is to a closed pipe, a sight glass is also connected around the orifice plate, so that a certain amount of washwater is forced through the glass, enabling the operator to determine when the backwashing is complete.

The supports for the filter body are placed underneath the conical shell, so that filtering units can be set close together, with some saving in floor space. There is also a saving in weight, due to the smaller cubical capacity of the shell for a given area of sand layer, and to the fact that the shell does not contain so large a volume of filling material as do strainer filters, where the strainer heads and manifold are usually imbedded in concrete. Altogether there is a total saving of about 20 per cent in weight.

If it should be desired to remove the filtering material, as is sometimes necessary when filtering greasy water, such as condensate, the sand and gravel do not have to be shovelled out but can be dropped out when the gate or door at the bottom of the filter body is opened. Fresh filtering material is then charged in the proper order through a manhole opening in the domed top of the shell.

Manufacturers' Latest Publications

New Department Mfg. Co., Bristol, Conn.—Folder No. 20—A folder on the use of ball bearings in motors.

The Pfaudler Co., Rochester, N. Y.—Bulletin No. 671—A bulletin describing an improved type of emulsifier for use in the food product and other industries.

Kinney Mfg. Co., Boston, Mass.—A catalog describing the design and use of the Heliquad pump, a new design of positive pump for handling all types of liquids.

Midwest Air Filters, Inc., Bradford, Pa.—A new folder illustrating some of the ways in which these air filters have been of value to various industries.

The Pittsburgh Coal Washer Co., Fulton Building, Pittsburgh, Pa.—Bulletin No. 25—A bulletin describing the design of the Pittsburgh vibratory screen for separating and sizing materials.

De Laval Steam Turbine Co., Trenton, N. J.—Bulletin E-1079—A new catalog describing centrifugal mine pumps.

Chowning Regulator Corp., Corning, N. Y.—A catalog describing the design and use of regulators for gas producers.

Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.—Bulletins No. 1653-A and 1670-A—The first of these publications describes the application of oil circuit-breakers, the determination of short circuit currents and gives tables and charts. The second of these publications discusses power factor correction and selection of corrective equipment, describes type LD static condensers, and also describes low voltage static condensers.

Traylor Engineering & Mfg. Co., Allentown, Pa.—Bulletin No. 1106—A new bulletin describing and giving the specifications of heavy duty crushing rolls.

The Barber Asphalt Co., Philadelphia, Pa.—Bulletin No. 1—A catalog of "Aterite" valves and fittings for oil refinery and general chemical plant use.

Cambridge Instrument Co., Grand Central Terminal, New York, N. Y.—A folder on dial thermometers.

Taylor Instrument Co., Rochester, N. Y.—Catalog 8,000—A new edition of this company's catalog of recording thermometers, gages and index thermometers.

Taylor Instrument Co., Rochester, N. Y.—Bulletin No. 8,000-D—A bulletin describing a distance reading electric transmitting recording thermometer or pressure gage.

Fisher Scientific Co., Pittsburgh, Pa.—A price list of the 1926 spring clearance sale of laboratory apparatus.

New Departure Mfg., Bristol, Conn.—Bulletin No. 171 FE—A bulletin on the use of ball bearings in temperature regulators.

Steere Engineering Co., Detroit, Mich.—Bulletin No. 42—A new catalog describing the design and operation of the water gas machines made by this concern.

Brown Instrument Co., Philadelphia, Pa.—A new bulletin entitled "Instructions for Installation and Care of Thermo-Electric Pyrometers." A catalog, No. 92, describing resistance thermometers for measuring temperatures from —300 to +1,000 deg. F. of the indicating, controlling and recording type. Also a folder entitled "Tell Mr. Jones" on the use of recording pyrometers in heat treating work.

Steere Engineering Co., Detroit, Mich.—Pamphlet No. 276—A leaflet describing a steel blast gate for use in gas plants.

American Blower Co., Detroit, Mich.—Bulletin No. 4313—A bulletin describing the method of installing No. 2½ reversible Ventura fan and permanent wall fixture.

Bridgeport Brass Co., Bridgeport, Conn.—A bulletin describing brass traffic spots for installing in pavements to give permanent traffic directions.

The Patterson Foundry & Machine Co., East Liverpool, Ohio.—A catalog describing the design and use of the agitating and mixing machinery made by this company. Also, a general folder dated March 29 describing some of the process equipment made by this company.

Pennsylvania Pump & Compressor Co., Easton, Pa.—Bulletins Nos. 127 and 207—The first of these describes direct connected synchronous motor-driven air compressors, and the second describes multi-stage centrifugal pumps, class OMS.

J. Bishop & Co., Malvern, Pa.—A bulletin entitled "The One Ten-Thousandth," describing spinerets for use in the manufacture of rayon.

Charles Engelhard, Inc., 30 Church Street, New York, N. Y.—A bulletin on the Type S Recorder describing the various charts and scales available with the instrument.

General Electric Co., Schenectady, N. Y.—Bulletin No. GEA-224, describing 60-ton electric storage battery type industrial locomotives. Bulletin No. GEA-32, dealing with power factor and means for its improvement. Bulletin No. GEA-352, describing capacitors for giving more power over the same line.

The International Nickel Co., 67 Wall St., New York City—A folder illustrating some of the uses of nickel steel.

Uehling Instrument Co., Paterson, N. J.—Bulletin No. 150—A bulletin describing a new combined barometer and vacuum recorder for use with steam turbines.

The Wellman-Seaver-Morgan Co., Cleveland, Ohio—Bulletin No. 85—A bulletin describing mechanical gas producers, type L. This bulletin also gives a number of tables and describes the operation of the producer and its use with different types of coal.

H. H. Robertson Co., Pittsburgh, Pa.—A folder describing the application of Robertson ventilators in a rolling mill building.

Pacific Foundry Co., San Francisco, Cal.—Bulletin No. 90—A new bulletin describing the use of "Corrosiron," a high silicon alloy used for making acid resisting castings.

Whitney Mfg. Co., Hartford, Conn.—A catalog describing driving chains of the silent type for power transmission.

Central Scientific Co., 460 E. Ohio St., Chicago, Ill.—A number of bulletins describing and giving the latest list prices of different types of laboratory apparatus.

Central Scientific Co., 460 E. Ohio St., Chicago, Ill.—Bulletin No. 101—A catalog giving specifications of certified chemicals.

Quigley Furnace Specialties Co., 26 Cortland Street, New York, N. Y.—A bulletin describing the refractory gun for making repairs and maintaining furnace linings.

Hagan Corporation, Pittsburgh, Pa.—A pamphlet containing an article by R. E. Hall, entitled "Essentials of Correct Boiler Water Conditioning."

Sturtevant Mill Co., Harrison Square, Boston, Mass.—A bulletin entitled "Amateur vs. Professional," describing standard units of conveying apparatus.

The Maxim Silencer Co., Hartford, Conn.—A folder on the industrial use of Maxim silencers.

C. J. Tagliabue Manufacturing Co., 18 33rd Street, Brooklyn, N. Y.—Two new pamphlets on the use of Tagliabue recording instruments in general plant operation.

American Pulverizer Co., St. Louis, Mo.—A folder describing a ring coal crusher for crushing coal for stoker use.

The Foxboro Co., Foxboro, Mass.—Bulletin No. 157—A folder describing the use of recording gages.

New Jersey Foundry & Machine Co., 90 West Street, New York, N. Y.—A folder showing various types of handling equipment made by this concern.

Technical Service Co., 233 Broadway, New York, N. Y.—A leaflet containing an article by H. R. Parker entitled, "The Control of Industrial Waste."

Celite Products Co., 11 Broadway, New York, N. Y. — Bulletin 317 — A bulletin giving specifications for the admixture of Celite in concrete.

Palo Co., 163 West 23rd Street, New York, N. Y.—Two new folders giving prices on various types of laboratory apparatus.

Patents Issued April 6 to May 4, 1926

Paper, Pulp and Sugar

Process for Producing Paper Pulp from Raw Stock. Charles W. Shartle, Middletown, Ohio.—1,582,351.

Paper Making. William A. Lorenz, Hartford, Conn., assignor to The Otaka Fabric Company, Hartford, Conn.—1,582,838.

Paper-Making Machine. William H. Engel, Kaukauna, Wis., assignor of one-half to Thilmany Pulp & Paper Company, Kaukauna, Wis.—1,583,130.

Paper-Making Machine. Frank W. Monaghan, Watertown, N. Y., assignor to The Bagley and Sewall Company.—1,581,655.

Paper-Pulp-Beating Engine. Charles Whitney Morden, Portland, Ore.—1,581,464.

Production of Pulp and Other Products from Wood. Linn Bradley, Montclair, N. J., and Edward P. McKeefe, New York, N. Y. —1,581,671.

Process for Treating Pulp. William D. Gregor, Wesley M. Osborne, and Alex J. Kemzura, Newton Falls, N. Y.—1,579,525.

Method of Hydrating Cellulose Fibers. Judson A. De Cew, Mount Vernon, N. Y., assignor to Process Engineers Inc., New York, N. Y.—1,580,814.

Process of Producing Paper Pulp. Eddie Lambert and Walter E. Matthews, Baltic, Conn.—1,582,336.

Method and Apparatus for Defibering Paper and Like Materials. Otto C. Winestock, Perkinsville, Vt.—1,579,461.

Digester. John W. Van Alstyne, Vancouver, Wash.—1,579,261.

Process for Regenerating Black Liquor. Alfred H. White, Ann Arbor, Mich. assignor to John E. Alexander, Port Edwards, Wis., and E. G. Goodell, Stevens Point, Wis., trustees.—1,580,269.

Method for Economic Disposal of Waste Sulphite Liquor in the Manufacture of Sulphite Pulp. Alfred M. Thomsen, Floristom, Calif., assignor to Crown Willamette Paper Company, San Francisco, Calif.—1,582,317.

Marbleizing Paper. Josef Lecjaky, New York, N. Y., assignor to Joseph Sec, New York, N. Y.—1,579,872.

Artificial Parchment and Method of Making the Same. Joseph T. Van Der Gracht, Campbell, Calif.—1,582,319.

Process for the Manufacture of Sugar. Herman Schreiber, Lansing, Mich.—1,581,663.

Process for the Preservation of Sugar. William L. Owen, New Orleans, La., dedicated, by mesne assignments, to the People of the United States.—1,579,387.

Rubber and Synthetic Plastics

Process of Vulcanizing Caoutchouc and Product Obtained Thereby. Dexter N. Shaw, Philadelphia, Pa., assignor to The Goodyear Tire & Rubber Company, Akron, Ohio.—1,580,089.

Method of Vulcanizing Caoutchouc and Product Produced Thereby. Lorin B. Sebrell, Akron, Ohio, assignor to The Goodyear Tire & Rubber Company, Akron, Ohio. —1,583,763.

Method of Vulcanizing Caoutchouc and Product Produced Thereby. Lorin B. Sebrell, Akron, Ohio, assignor to The Goodyear Tire & Rubber Company, Akron, Ohio.—1,583,761.

Process of Uniting Rubber and Metal. Robert Morse Withycombe, Sydney, New South Wales, Australia.—1,581,823.

Coating Composition Containing Nitrocellulose and Hard Rubber. Samuel E. Sheppard and John J. Schmitt, Rochester, N. Y., assignors to Eastman Kodak Company, Rochester, N. Y.—1,583,703.

Polyhydric Alcohol-Organic Acid Resinous Condensation Products. James G. E. Wright, Alplaus, N. Y., assignor to General Electric Company.—1,581,902.

Process for the Production of Hard Resinous Bodies. Eugen Schaal, Feuerbach, Germany.—1,583,014.

Magnesium-Containing Synthetic Resin and Process of Making Same. Carleton Ellis, Montclair, N. J., assignor to Ellis-Foster Company.—1,580,424.

Petroleum Refining

Distillation of Crude Petroleum. Edgar Milton Clark, New York, N. Y., assignor to Standard Development Company.—1,582,123.

Apparatus for Treating Hydro-Carbon Oils. Carbon P. Dubbs, Wilmette, Ill., assignor to Universal Oil Products Company, Chicago, Ill.—1,582,585.

Apparatus for Cracking Hydrocarbons. Frank E. Wellman, Kansas City, Kans., assignor to The Kansas City Gasoline Company, Kansas City, Kan.—1,581,895.

Apparatus for Refining Oils. Daniel Pyzel, Piedmont, Calif., assignor to Simplex Refining Company, San Francisco, Calif.—1,583,746.

Pressure Oil Still. Robert E. Humphreys, Whiting, Ind., assignor to Standard Oil Company, Whiting, Ind., and Chicago, Ill. —1,582,929.

Apparatus for Treating Hydrocarbon Oils. Otto Behimer, Port Arthur, Tex., assignor to The Texas Company, New York, N. Y.—1,582,893.

Apparatus for Hydrocarbon-Oil-Cracking Operations. Kenneth V. King, Berkeley, Calif., assignor to Standard Oil Company, San Francisco, Calif.—1,582,407.

Castor Machine Oils. De Ralph Frizell, Los Angeles Calif., assignor to Union Oil Company of California, Los Angeles, Calif. —1,582,258.

Preparing Soluble Oils. De Ralph Frizell, Los Angeles, and Bert Allen Stagner, Berkeley, Calif., assignors to Union Oil Company of California, Los Angeles, Calif. —1,582,257.

Preparing Castor Machine Oils. Leland L. Rebber, Los Angeles, Calif., assignor to Union Oil Company of California, Los Angeles, Calif.—1,582,227.

Process of Manufacturing Lubricating Oils. James W. Weir, Fillmore, Calif.—1,581,370.

Method of Refining Lubricating Oil Stocks. James W. Weir, Fillmore, Calif.—1,581,369.

Art of Removing Wax from Oil. Harry F. Glair and Oscar E. Bransky, Whiting, Ind., assignors to Standard Oil Company, Whiting, Ind., and Chicago, Ill.—1,582,923.

Dephlegmator. Gustav Egloff and Harry P. Benner, Chicago, Ill., assignors to Universal Oil Products Company, Chicago, Ill. —1,582,588.

Gas and Oil Separator. Edwin C. Weisgerber, Long Beach Calif.—1,581,371.

Method of Heating Oil. Frank E. Wellman, Kansas City, Kans., assignor to The Kansas City Gasoline Company, Kansas City, Kan.—1,581,896.

Method of Recovering a Metallic Halide from Hydrocarbon Sludges. Philip S. Danner, Point Richmond, Calif., assignor to Standard Oil Company, San Francisco, Calif.—1,582,131.

Process for the Production of Fuel Mixtures. Thomas Howard Butler, Bristol, Herbert William Robinson, Cleobury Mortimer, and Deric William Parkes, Birmingham, England.—1,583,573.

Dehydrator for Petroleum Emulsions. Edwin F. Hurst, Brea, Calif.—1,582,404.

Process of Preventing the Persistence of Chain Formations in Electrical Dehydrator for Oil Emulsions. Ford W. Harris, Los Angeles, Calif., assignor to Petroleum Rectifying Company of California, Los Angeles, Calif.—1,581,205.

Process of Dehydrating Oil. Harold C. Eddy, Los Angeles, Calif., assignor to Petroleum Rectifying Company of California. 1,580,591.

Process for Dehydrating Emulsions, William Cameron, Suez, Egypt, assignor to Simplex Refining Company, San Francisco, Calif.—1,580,956.

Apparatus for Treating Oils. Perry Cassidy, Riverside, Conn., assignor to The Babcock & Wilcox Company, Bayonne, N. J. —1,582,899.

Purifying and Declorizing Agent for Oils and Method of Making the Same. Harold L. Kauffman, Parco, Wyo., assignor to Producers and Refiners Corporation.—1,579,326.

Treatment of Waste Products Resulting from Acid Treatment of Petroleum Oil. Ralph A. Halloran, Berkeley, William N. Davis, Oakland, and George A. Davidson, San Francisco, Calif., assignors to Standard Oil Company, San Francisco, Calif.—1,579,607.

Process of Desulphurizing Petroleum Oils. James B. Rather, Brooklyn, N. Y., assignor to Standard Oil Company of New York, New York, N. Y.—1,580,531.

Apparatus for Converting Higher-Boiling-Point Hydrocarbon Oils Into Lower-Boiling-Point Hydrocarbon Oils. William M. McComb, New York, N. Y.—1,579,554.

Organic Processes

Triphenylmethane Dye. Walter Duisberg, Winfried Hentrich and Wilhelm Schepss, Wiesdorf-on-the-Rhine, Germany, assignors, by mesne assignments, to Grasselli Dyestuff Corporation, New York, N. Y. —1,582,909.

Process of Manufacturing Vat Coloring Matters. Arthur Lüttringhaus, Mannheim, Heinrich Neresheimer, Ludwigshafen-on-the-Rhine, and Hans Emmer, Mannheim, Germany, assignors to Badische Anilin- & Soda-Fabrik, Ludwigshafen-on-the-Rhine, Germany.—1,580,062.

Production of Vat Dyestuff. Donald G. Rogers and Lloyd C. Daniels, Buffalo, N. Y., assignors to National Aniline & Chemical Company, Inc., New York, N. Y.—1,583,258.

Black Vat Dyestuff Composition. Richard Just, Ludwigshafen-on-the-Rhine, Karl Wilke, Hochst-on-the-Main, and Paul Nawiasky, Ludwigshafen-on-the-Rhine, Germany, assignors to Badische Anilin- & Soda-Fabrik, Ludwigshafen-on-the-Rhine, Germany.—1,581,628.

Vat Dyestuff and Process of Making Same. Georg Kränzlein, Heinrich Greune, Robert Sedlmayr, and Heinrich Vollmann, Hochst-on-the-Main, Germany, assignors to Grasselli Dyestuff Corporation, New York, N. Y.—1,582,475.

Vat Coloring Matter. Arthur Lüttringhaus, Mannheim, and Arthur Wolfram, Frankfort-on-the-Main, Germany, assignors to Badische Anilin- & Soda-Fabrik, Ludwigshafen-on-the-Rhine, Germany.—1,582,844.

Process of Producing N-Dihydro-1,2,1',2'-Anthraquinone-Azine and Its Derivatives. Merville S. Thompson, Penns Grove, N. J., assignor to E. I. du Pont de Nemours & Company, Wilmington, Del.—1,580,700.

Brown Copper Containing Aromatic Amine-Sulphur Dyes and Process of Making the Same. Joseph Flachslaender and Laurie L. Burgess, Wilmington, Del., assignors to E. I. du pont de Nemours & Company, Wilmington, Del.—1,580,716.

Purification of Anthraquinone. Harry F. Lewis, Buffalo, N. Y., assignor to National Aniline & Chemical Company, Inc., New York, N. Y.—1,583,297.

Process of Producing Naphtholsulphonic Acids. Paul H. Fall, Carneys Point, N. J., and Ira E. Lee, Wilmington, Del., assignors to E. I. du Pont de Nemours & Company, Wilmington, Del.—1,580,714.

Acid Azo Dyestuffs for Wool Containing Chromium and Process for the Manufacture of Same. Hermann Fritzsche, Hans Gubler, and Fritz Straub, Basel, Switzerland, assignors to The Society of Chemical Industry in Basle, Basel, Switzerland.—1,581,572.

Hydrogenation of Naphthalene. Georg Schroeter, Berlin, Germany.—1,582,310.

Azodyestuffs and Process of Making Same. Guillaume de Montmollin and Gérald Bonhôte, Basel, Switzerland, assignors to The Society of Chemical Industry in Basle, Basel, Switzerland.—1,582,029.

Purification of Alpha-Nitro-Naphthalene. Harold F. Whittaker, Carneys Point, N. J., and Walter Wollaston, Wilmington, Del., assignors to E. I. du Pont de Nemours & Company, Wilmington, Del.—1,581,258.

Anthracene Dye and a Process of Making. Robert J. Goodrich, South Milwaukee, Wis., assignor to The Newport Company, Milwaukee, Wis.—1,581,111.

Purification of Phenolphthalein. John George Schudel, Buffalo, N. Y., assignor to National Aniline & Chemical Company, Inc., New York, N. Y.—1,583,372.

Process for Treating Viscose Silk in a Vacuum. Adolf Kämpf, Premnitz, Germany.—1,579,711.

Process of Manufacture of Artificial Silk and of Artificial Threads or Filaments. Joseph Edouard Gustave Lahousse, Ternay, France, assignor to Societe pour la Fabrication de la Soie "Rhodiaseta," Paris, France. —1,583,475.

Manufacture of Artificial Silk and Like Materials from Viscose Solutions. William Porter Dreaper, London, England.—1,583,534.

Cellulose-Ether Film and Composition for Making the Same. William R. Webb, Rochester, N. Y., assignor to Eastman Kodak Company, Rochester, N. Y.—1,583,709.

Manufacture of Artificial Silk from Viscose. William Mendel, Beverly, N. J., assignor to Samuel A. Neidich, Edgewater Park, N. J.—1,580,843.

Manufacture of Artificial Silk from Viscose. William Mendel, Beverly, N. J., assignor to Samuel A. Neidich, Edgewater Park, N. J.—1,580,844.

Cellulose Nitrate Composition. Stewart J. Carroll, Rochester, N. Y., assignor to Eastman Kodak Company, Rochester, N. Y. —1,580,189.

Process of Manufacture of Acetic Anhydride and Aldehyde. Gustave Jean Roy, Lyon, France, assignor to Societe Chimique des Asines du Rhone, Paris, France.—1,579,248.

Oxidation of Ethyl Alcohol to Acetaldehyde. Erich Krause, Constance, Ger-

many, assignor, by mesne assignment, to The Roessler & Hasslacher Chemical Company, New York, N. Y.—1,581,641.

Process of Manufacturing Alcohol by Fermentation. Henry W. Dahlberg, Denver, Colo., assignor to The Great Western Sugar Company, Denver, Colo.—1,581,001.

Production of Esters. David A. Legg and Charles Bogin, Terre Haute, Ind., assignors to Commercial Solvents Corporation, Terre Haute, Ind.—1,580,143.

Process for the Production of Butyl Alcohol and Acetone. David A. Legg, Terre Haute, Ind., assignor to Commercial Solvents Corporation, Terre Haute, Ind.—1,582,408.

Manufacture of Normal Butyric Acid from Butyl Aldehyde. Clarence W. Hancock, Terre Haute, Ind., assignor to Commercial Solvents Corporation, Terre Haute, Ind.—1,580,137.

Manufacture of Butyric Acid. David A. Legg and Clarence W. Hancock, Terre Haute, Ind., assignors to Commercial Solvents Corporation, Terre Haute, Ind.—1,580,144.

Process of Manufacturing Yeast. Henry W. Dahlberg, Denver, Colo.—1,581,000.

Process of Manufacturing Yeast. Henry W. Dahlberg, Denver, Colo.—1,580,999.

Process of Halogenizing Perylene. Alois Zinke and Alfred Pongratz, Gratz, Austria, assignors to Felice Beusa, Genoa, Italy.—1,580,708.

Di-Acylacetyl-Diamino Compounds of the Aromatic Series and Process of Making Same. Arthur Zitscher and Robert Schmitt, Offenbach-on-the-Main, Germany, assignors to Chemische Fabrik Griesheim-Elektron, Frankfort-on-the-Main, Germany.—1,580,709.

Manufacture of Glutamic Acid and Salts Thereof. Kikunaë Ikeda, Tokyo, Japan.—1,582,472.

Process for the Preparation of Hydroxy Aliphatic Arsonic Acids. Carl Oechslin, Ablon, France, assignor to Etablissements Poulenc Frères, Paris, France.—1,582,775.

Orthobenzylphenol and Process of Preparing the Same. Walther Kropp and Wilhelm Schranz, Elberfeld, and Werner Schulemann, Vohwinkel, Germany, assignors to Farbenfabriken vorm. Friedr. Bayer and Co., Leverkusen, near Cologne-on-the-Rhine, Germany.—1,580,053.

Production of Amide Acid Sulphates from Nitriles. Ralf B. Trusler, Pittsburgh, Pa., assignor to The Roessler & Hasslacher Chemical Company, New York, N. Y.—1,581,621.

Effecting Catalytic Reactions, Particularly in Catalytically Producing Hydrocyanic Acid. Alwin Mittasch and Wilhelm Michael, Ludwigshafen-on-the-Rhine, Germany, assignors to Badische Anilin- & Soda-Fabrik, Ludwigshafen-on-the-Rhine, Germany.—1,582,851.

Manufacture of 1-Phenyl-2.3-Dimethyl-4-Dimethylamino-5-Pyrazolon. Georg Lockemann, Berlin, Germany.—1,580,059.

Process of Preparing Pentaerythritol Tetracetate. Hans T. Clarke, Rochester, N. Y., assignor to Eastman Kodak Company, Rochester, N. Y.—1,583,658.

Silver-Protein Preparation. Ludwig Taub, Hermann Janssen, and Georg Wesenberg, Elberfeld, Germany, assignors, by mesne assignments, to Winthrop Chemical Company, Inc., New York, N. Y.—1,582,940.

Arsenical Albumen Compound and Method of Making the Same. Oscar Bally, Basel, Switzerland, assignor to the firm: Haco-Gesellschaft A.-G. Bern, Bern, Switzerland.—1,581,826.

Recovery of Antimony in the Manufacture of Flavanthrone. William A. Adamson, Wilmington, Del., and Paul W. Carleton, Penns Grove, N. J., assignors to E. I. du Pont de Nemours & Company, Wilmington, Del.—1,582,328.

Recovery of Phenols and Cresols. Robert M. Crawford, Pittsburgh, Pa.—1,582,512.

Purification of Starch. Martin J. Prucha, Urbana, Ill., and John Max Widmer, Cedar Rapids, Iowa, assignors to Penick & Ford Ltd. Incorporated.—1,582,537.

Inorganic Processes

Process of Separating Hafnium and Zirconium. Dirk Coster, Haarlem, Netherlands, and Georg von Hevesy, Copenhagen, Denmark, assignors to Naamlooze Vennootschap Philips' Gloeilampen-Fabrieken.—1,580,650.

Process of Separating Hafnium and Zirconium. Anton Eduard van Arkel and Jan Hendrik de Boer, Eindhoven, Netherlands, assignors to N. V. Phillips' Gloeilampen-Fabrieken, Eindhoven.—1,582,860.

Production of Zirconium Oxide. Hugh S. Cooper and Le Rue P. Bensing, Cleveland, Ohio, assignors to Kemet Laboratories Company, Inc., Cleveland, Ohio.—1,582,126.

Process for Treating Crude Oxide and Carbonate of Zinc. William Thomas Gidden, Smethwick, and William Gilbert Ragg, Birmingham, England, assignors to Chance and Hunt, Limited, Oldbury, England.—1,579,302.

Artificial Aluminous Abrasive and Process of Making Same. Harold Anthony Richmond, Porter, and Robert Macdonald, Jr., Niagara Falls, N. Y., assignors to General Abrasive Company, Inc., Niagara Falls, N. Y.—1,583,179.

Process for Making Metallic Chromium. William E. S. Strong and Charles E. Parsons, New York, N. Y., and Samuel Peacock, Wheeling, W. Va., assignors to Metal Research Corporation, New York, N. Y.—1,581,698.

Process of Producing Commercial Hydrochloric Acid. Hugh G. Galt, Akron, Ohio, assignor to Pittsburgh Plate Glass Company.—1,581,436.

Process for the Synthesis of Ammonia. Georges Claude, Paris, France, assignor, by mesne assignments, to Lazote Inc.—1,579,647.

Process of Making Lead Sulphate. Stanley Cochran Smith, London, England, assignor of one-half to Frank Edward Elmore, Three Fields, England.—1,581,031.

Sodium Compound and Process of Forming the Same. Herbert Edwin Cocksedge, Hartford, England, assignor to The Solvay Process Company, Solvay, N. Y.—1,583,660.

Insecticidal Composition. Henry Howard, Cleveland, Ohio, assignor to The Grasselli Chemical Company, Cleveland, Ohio.—1,583,154.

Process of Manufacturing Sodium Fluoride from Silicofluorine Compounds. Wilhelm Siegel, Berlin-Charlottenburg, Germany.—1,581,819.

Recovery of Hydrogen Sulphide. Frederick W. Sperr, Jr., Pittsburgh, Pa., assignor to The Koppers Company, Pittsburgh, Pa.—1,580,452.

Manufacture of Hydrogen Sulphide. Frederick W. Sperr, Jr., Pittsburgh, Pa., assignor to The Koppers Company, Pittsburgh, Pa.—1,580,451.

Method of Manufacturing Hydrated Lime. Charles I. Chubbuck, San Francisco, Calif.—1,580,710.

Process in Recovering Calcium Hydrate. George M. Drummond, Colorado Springs, Colo., assignor to Holly Sugar Corporation, Colorado Springs, Colo.—1,580,024.

Process for the Production of Superphosphates. Bethune G. Klugh, Anniston, Ala., assignor to Federal Phosphorus Company, Birmingham, Ala.—1,583,054.

Making a Calcium-Nitrate Fertilizer. Wilhelm Wild and Karl Eyer, Ludwigshafen-on-the-Rhine, Germany, assignors to Badische Anilin- & Soda-Fabrik, Ludwigshafen-on-the-Rhine, Germany.—1,579,989.

Manufacture of Hydrogen by the Partial Liquefaction of Gaseous Mixtures. Georges Claude, Paris, France, assignor, by mesne assignments, to Lazote Inc.—1,579,348.

Ammonia Distillation. John S. Unger, Chicago, Ill.—1,581,367.

Electrolytic Cells and Processes

Process of Electrodepositing Iron from Iron-Containing Minerals. Masatosi Okochi and Motokiti Hanaoka, Tokyo, Japan, assignors to Zaidan Hojin Rikagaku Kenkyujo, Tokyo, Japan.—1,582,423.

Producing Calcium Hypochlorite Compounds. Gustav Pistor and Hermann S. Schultze, Griesheim-on-the-Main, and Heinrich Reitz, Bitterfeld, Germany, assignors to The Chemische Fabrik Griesheim-Elektron, Frankfort-on-the-Main, Germany.—1,583,421.

Process of Electrodepositing Chromium and of Preparing Baths Therefor. Colin G. Fink, New York, N. Y., assignor to Chemical Treatment Company, Inc., New York, N. Y.—1,581,188.

Production of Compressed Gases by Electrolysis. Paul Hausmeister, Goppingen, Germany.—1,581,944.

Electrodeposition of Organic Materials. Samuel E. Sheppard and Leon W. Eberlin, Rochester, N. Y., assignors to Eastman Kodak Company, Rochester, N. Y.—1,580,795.

Dry Cell. William Ramsay, Westfield, N. J., assignor to Manhattan Electrical Supply Company, Incorporated, New York, N. Y.—1,582,687.

Electrodeposition of Rubber Under Gas-Removing Conditions. Samuel E. Sheppard and Leon W. Eberlin, Rochester, N. Y., assignors to Eastman Kodak Company, Rochester, N. Y.—1,583,704.

Electrolytic Cell. Franz Petz, Nuremberg, Germany, assignor to Elektrizitäts-Aktiengesellschaft Vormals Schuckert & Co., Nuremberg, Germany.—1,579,138.

Electrolytic Separation Apparatus. August Dassbach, Hanan-on-the-Main, Germany, assignor to Irvington Smelting & Refining Works, Irvington, N. J.—1,577,898.

Process for the Electroosmotic Purification of Glue and Gelatin. Wilhelm Ruppel, Berlin, and Kuno Wolf, Berlin-Charlottenburg, Germany, assignors, by mesne assignments, to American Electro-Osmosis Corporation, New York, N. Y.—1,577,660.

Manufacture of Gelatin Suitable for Emulsions. Alexander Jenny and Johannes Angerstein, Berlin, Germany, assignors, by mesne assignments, to American Electro-Osmosis Corporation, New York, N. Y.—1,577,642.

Method and Apparatus for Protection of Metallic Surfaces. Guy H. Elmore and Henry J. Creighton, Swathmore, Pa., assignors to Antiscale Corporation, Philadelphia, Pa.—1,576,581.

Electrode for Electrolytic Cells. Humphreys O. Siegmund, West Orange, N. J., and Ben Eli Brown, New York, N. Y., assignors to Western Electric Company, Incorporated, New York, N. Y.—1,578,857.

Process for Producing Ozone. Alfred Starke, Scottdale, Pa., and Hans von Wartenberg, Danzig-Langfuhr, Free State of Danzig, assignors to the Firm of Ozonhochfrequenz G. m. b. H., Berlin-Wilmersdorf, Germany.—1,579,162.

Electrode for Use in the Electrolytic Evolution of Gases. Ernst Heinze, Leverkusen, near Cologne, Germany, assignor to Farbenfabriken vorm. Friedr. Bayer and Co., Leverkusen, near Cologne-on-the-Rhine.—1,575,627.

Chemical Engineering Equipment

Pulverizing Mill. Fred I. Raymond, Evanston, Ill., assignor to Raymond Brothers Impact Pulverizer Company, Chicago, Ill.—1,582,538.

Pulverizing Mill. Charles Boothe Strachan, Mascot, Tenn., assignor to Strachan Tube Mill Company.—1,583,324.

Pneumatic Classifier. Albert H. Stebbins, Los Angeles, Calif.—1,581,240.

Drying Apparatus. Crosby Field, New York, N. Y. Filed Jan. 5, 1921. Serial No. 435,272.—1,580,658.

Rotary Drying Apparatus. Charles Miller, Long Island City, N. Y.—1,581,359.

Steam Drier. Maurice Kaunitz and Samuel Lanzet, New York, N. Y.—1,583,354.

Process and Apparatus for Drying Coagulable Liquids. Ernest Hopkinson and Reed P. Rose, New York, N. Y., assignors to General Rubber Company, New York, N. Y.—1,582,604.

Process of and Apparatus for Multiple-Effect Evaporative Separation. Hugh K. Moore, Berlin, N. H., assignor to Brown Company, Berlin, N. H.—1,582,066.

Catchall for Multiple Effect Evaporators and Vacuum Pans. Pedro Mir, San Pedro de Marcoris, Dominican Republic.—1,581,220.

Process for Drying Smokeless Powders. James C. Vickery, Evansville, Ind., and Merle H. Davis, Fort Bragg, N. C.—1,579,262.

Continuous Tank Furnace. Enoch T. Ferngren, Toledo, Ohio, assignor to The Libbey-Owens Sheet Glass Company, Toledo, Ohio.—1,581,338.

Device for Burning Cement, Magnesite, Lime, etc. Harry Stehmann, Berlin-Hohenschonhausen, Germany.—1,581,522.

Apparatus for Determining Temperatures of Furnace Gases. Frederick D. Potter, Linden, N. J., assignor to Combustion Control Company, Inc.—1,583,097.

Method of Producing Hydrogen from Water Gas. Jules Hector De Graer, Brussels, Belgium.—1,583,673.

Process for Oxidizing or Carbonizing Fuel. Utley Wedge, Paoli, Pa.—1,582,952.

Lignite-Distillation Apparatus. John E. Neumaier, Dayton, Ohio, assignor to The Lignite Pressed Coal Company, Dayton, Ohio.—1,582,297.

Heat Exchange. Harold W. Fletcher, Houston, Tex., assignor of one-third to J. E. Schroeder, Harris County, Tex.—1,580,126.

Process for Treating Vegetable Substances and Extracting Therefrom Fibrous Substances. Paul Köppel, Karlsruhe, Germany.—1,582,053.

Tanning and the Manufacture of Tanning Materials. James Alexander Shepherd Morrison, Grappenhall, England.—1,581,224.

Pulverization of Coal. Henry Kreisinger, Piermont, N. Y., assignor to Combustion Engineering Corporation, New York, N. Y.—1,576,335.

Drying Apparatus. Olof Söderlund, Teofron Boberg, and Lils Testrup, London, England, assignors to Techno-Chemical Laboratories, Limited, London, England.—1,577,545.

Process of Filtration and Treatment of Liquids. Charles V. Zoul, Santa Monica, Calif., assignor to The Celite Company, Los Angeles, Calif.—1,579,171.

Filter Unit. James Jarvis Preble, Newton, Mass., assignor to Spray Engineering Company, Boston, Mass.—1,576,121.

Filtering and Thickening Process and Apparatus. Albert Legrand Genter, Salt Lake City, Utah, assignor of one-half to The General Engineering Company, Salt Lake City, Utah.—1,575,907.

News of the Industry

Technical Sessions Prominent at A.E.S. Meeting

The forty-ninth meeting of the American Electrochemical Society was held at the Chicago Beach Hotel, Chicago, April 22-24. The technical sessions comprised a symposium on chlorine, a roundtable luncheon discussion on "Selection of Proper Plating Metals" and another on "Comparative Merits of Electric- and Fuel-Fired Furnaces." Following the policy adopted at Dayton in 1924 the roundtable discussions were informal. No stenographic notes were taken and no detailed report is available. The success of these round table discussions warrants the personal attendance of all who are interested in the topics. A report of the technical features of the meeting is printed elsewhere in this issue.

At the annual business meeting the following officers were elected: President, William Blum, Bureau of Standards; Vice-Presidents, Paul D. Merica, International Nickel Company; Bradley Stoughton, Lehigh University and O. P. Watts, University of Wisconsin; Managers, William G. Harvey, American Magnesium Corporation; B. D. Saklatwalla, Vanadium Corporation of America and George B. Hogaboom, Hanson and Van Winkle; Treasurer, Acheson Smith, Acheson Graphite Corporation, and Secretary, Colin G. Fink, Columbia University.

Dr. Edward Weston was elected to honorary membership in the Society. Formal presentation was postponed until the Fall meeting of the Society in Washington, which will be held at Hotel Washington, Oct. 7-9. At this meeting the subject of the symposium will be "Materials for Extreme Conditions in the Electrochemical Industry." The annual meeting for 1927, which will mark the 25th anniversary of the foundation of the Society, will be held in Philadelphia where it was organized.

The addresses of retiring President F. M. Becket, on "An Opportunity for Conservation" was well received. His theme was the waste of technical effort in experimental work due to a failure to estimate costs. The address is published practically in full elsewhere in this number.

Jersey Plant Will Manufacture Tetraethyl Lead

As the result of the placement of new contracts between the du Pont Company and the Ethyl Gasoline Corporation, distributors of tetraethyl lead, which was manufactured at the Deepwater Point, N. J., plant of the du Pont Company, the work will be resumed about June 1. The plant was closed several months during the investigation of the product by the government which resulted in a favorable decision.

In addition to making the tetraethyl lead at the dye works, a building is also being erected at the plant for the blending of the tetraethyl lead and other ingredients to form ethyl fluid for the Ethyl Gasoline Corporation.

Heretofore the tetraethyl has been shipped to Dayton, Ohio, where it was blended and distributed to the customers of the corporation.

Phenolic Resin Subject of Tariff Hearing

The Tariff Commission will conduct a hearing May 24 on complaint of the Bakelite Corporation and others regarding alleged unfair methods of competition by foreign firms in importations and sales of synthetic phenolic resin of form C and articles made from this resin. The hearing is ordered under Section 316 of the 1922 tariff act, which is the flexible provision dealing with unfair methods of competition. Investigations regarding synthetic phenolic resin in one form or another have been before the Commission for two years.

Amendments To Flexible Tariff May Be Recommended

Indications are that the special Senate committee investigating the Tariff Commission will present a divided report as to the history of that agency's functioning under the flexible tariff provisions, but with a possibility that an agreement may be reached by the five senators with regard to recommendations for amendments to the law.

While the flexible tariff has been under fire during the hearings, the criticisms have been directed mainly at matters which are those of opinion among members of the Commission, but strong suggestions have been given the committee that the law should be amended. The outstanding suggestions have tended toward clarifying the intent of Congress toward the flexible tariff and broadening the language of such sections so that the Commission, in conducting investigations upon which the President may make changes in duties, may not be confined so narrowly to differences in costs of production.

Editors Present Testimonial To Secretary Hoover

A recognition of "a new leadership in American business" led to the arrangement five years ago of frequent conferences of the business paper editors of the country with Secretary of Commerce, Herbert Hoover. These meetings were for the discussion of important technical and economic questions of the day under the auspices of the National Conference of Business Paper Editors. On May 10 there was celebrated the fifth anniversary of the founding of this conference by a meeting of one hundred of the editors and publishers of the leading trade and technical magazines of the country at dinner with Mr. Hoover. On this occasion there was again emphasized the great debt of the business press to the Secretary and the great benefit which has come to American business through the leadership which he has offered, both direct and through the trade and technical periodicals.

These conferences, as pointed out by three of the speakers, came about through the necessity of attending to business at a time when the entire reconstruction of our industrial fabric was needed, the utmost of editorial assistance and leadership. And as expressd by one of these speakers "the strongest force in education of the public business mind was the Department of Commerce under the leadership of Mr. Hoover."

The results of these conferences have afforded many benefits to the readers for which credit to Mr. Hoover could not be given because of the confidential nature of all remarks at these meetings, it was pointed out. Among these benefits as summarized by H. C. Parmelee, editor of *Chem. & Met.*, were three of peculiar interest to the chemical process industries. These were: (1) Clear economic thinking and real economic leadership. (2) Vitalized statistics, which are timely, prompt and significant. (3) A renewed faith and appreciation of the need for fundamental research.

As an evidence of the editors' appreciation there was presented to Mr. Hoover an engrossed testimonial. In acknowledgment of this Mr. Hoover expressed his regard not alone for the co-operation of the business press but also for the brillant leadership of business itself. It was pointed out that this leadership has brought the United States through the most difficult five years in its economic history to the highest standards of living ever attained.

Chemical Equipment Makers Meet in Cleveland

Exhibits of Equipment Supplemented By Meetings of Technical Societies

On the occasion of the second Chemical Equipment and Process Engineering Exposition of the Association of Chemical Enquipment Manufacturer's, held at Cleveland, Ohio, from May 10 to 12, a large gathering of members of engineering and technical societies held numerous technical sessions under the auspices of the Associated Technical Societies of Cleveland. In addition to attending these meetings and various luncheons and dinners given by societies and alumni groups, these technical men, together with many representatives of prominent manufacturing firms from all over the country, took advantage of the opportunity to inspect the equipment and accessories that were shown in the exhibition hall of the Cleveland Auditorium.

A high spot of the week was the banquet given at the Hollenden Hotel on Tuesday, May 11, with H. E. Howe, editor of *Industrial and Engineering Chemistry*, as toastmaster. The speakers at this dinner were Major General Amos A. Fries, chief of the Chemical Warfare Service and Benedict Crowell, formerly assistant secretary of war. Both of these speakers stressed the importance to the future safety of the country of readiness to engage in chemical warfare should the necessity arise. General Fries pointed out the advantage to peace time arts that comes from chemical preparedness and Mr. Crowell called attention to the fact that, in spite of popular opinion to the contrary, gas warfare is more humane than other defense methods.

At the technical sessions emphasis was placed on materials to withstand the adverse conditions of chemical engineering industries. Papers on this general topic included. "Corrosion Problems in the Heavy Chemical Industry" by A. E. Marshall; "Equipment Suggestions for High Pressure Reactions" by F. A. Ernst; "Electro Deposition of Chromium and Chromium Alloys on Brass and Steel" by C. G. Fink; "Alcumite—An Acid-Resisting Bronze" by W. M. Corse; "Glass as an Equipment Material" by A. E. Marshall; "Refractories as Adapted to the Ceramic Industry" by H. E. Ebright; "Acid-Proof Stoneware in the Chemical Industry" by M. A. Knight; "Welding of Large Chemical Equipment" by A. O. Miller; and "Rubber—An Effective Material to Resist Corrosion and Abrasion" by B. W. Rogers.

Other papers included: "Research Trends" by C. H. Herty; "Carbon Electrodes and the Electric Furnace Industry" by F. J. Vosburg; "Chemical Aspects of the Relation of Light to Life and Health" by W. A. Price; "Catalysis —An Industrial Development" by Hugh Taylor; "Probable Life of Our Merchantable Ores" by M. C. Lake; "Development of New Methods for Iron Ore Treatment" by E. W. Davis; "Art in the Ceramic Industry" by R. G. Cowan; "Some Chemical and Engineering Aspects of Dust Explosives" by D. J. Price; and "Diphenyl Oxide Bi-Fluid Power Plants" by H. H. Dow.

The equipment shown comprised in about 60 exhibits, included apparatus for mixing, agitating, separation, thickening, sedimentation, absorption, filtration, evaporation, crushing, grinding, pulverizing, centrifuging, distillation, drying, dissolving, leaching, extraction, precipitation, crystallization, refrigeration, heat transfer and material handling. There were also exhibited many materials to withstand corrosion and numerous controlling devices and other accessories.

Rayon Production in Germany Doubled Since 1923

The production of rayon in Germany especially of the viscose product, has increased considerably during the last few years, and German estimates of the total output of rayon in 1925 range from 26,000,000 lb. to 33,000,000 lb., compared with approximately 23,600,000 lb. in 1924 and 13,000,000 lb. in 1923, according to a report from assistant trade commissioner W. E. Nash, Berlin.

Between 60 and 70 per cent of the total German production of rayon is credited to the Vereinigte Glanzstoff-Fabriken of Elberfeld, a concern using the viscose process. This concern is reported in Germany to have combined recently with Courtauld's Limited, Great Britain, for the erection of a new unit in Cologne which will have a daily capacity of from 17,500 to 22,000 lb. of viscose rayon and which will employ approximately 4,000 workmen.

The market for rayon goods recently has been rather dull in Germany and sales dropped off during the first two months of 1926, but despite the decline in business German manufacturers profess to be confident of future prospects and one concern is planning to erect a new plant in Germany. Although the retail trade this spring is expected to be satisfactory in volume, it is believed by the trade that some time will be required before this improved turnover will react favorably on the manufacturing units. Short-time operation is the rule in many plants, while several others have shut down temporarily.

Chapter of Sigma Xi Installed at Cincinnati

Installation of a chapter of Sigma Xi at the University of Cincinnati took place April 29. Dr. Forrest R. Moulton, of the University of Chicago and president of the National Society, and Dr. H. P. Ward, of the University of Illinois, former president of the Society and acting for the National Secretary, were the installing officers. Following the installation, a banquet was held where the address of welcome was given by Dr. Frederick C. Hicks, president of the University of Cincinnati.

The officers of the new chapter are: President, Dr. O. C. Von Schlichten, Department of Geology; vice-president, Dr. G. D. McLaughlin, Department of Leather Research, Tanner's Council of America; secretary-treasurer, Dr. Saul B. Arenson, Department of Chemical Engineering. The petitioning group consisted of about forty, practically all being members elected at other chapters.

Increase In Production of Dyes Last Year

An approximate 25 per cent increase in American dye production in 1925 over 1924 was revealed in the preliminary figures compiled by the Tariff Commission.

Production totaled 86,000,000 lb. valued at $40,000,000, compared with 79,000,000 lb., valued at $36,000,000 in 1924. The increase was due largely to greater activity in the domestic textile industry and improvement in the export trade in indigo and sulphur black dyes.

Outstanding features of the year, the commission said, were continued recessions in dye prices due largely to severe competition among domestic manufacturers, and conspicuous progress in manufacture of fast dyes, many such dyes being produced in 1925 for the first time in the United States.

Dye imports showed increases of 75 per cent in quantity and 65 per cent in value, while dye exports increased 64 per cent in quantity and 19 per cent in value over those of 1924.

Stricter Enforcement of Laws on Coal-Tar Imports

Orders have been issued by the Treasury Department for more rigid enforcement of the proviso in paragraph 28 of the tariff act, applying to coal-tar dyes and other products, which requires that the invoice and the immediate container of importations shall bear a clear statement of the contents and strength. Collectors are authorized to seize shipments not complying with this proviso and to proceed for their forfeiture, with importers being given the right to carry cases to the Board of General Appraisers. Heretofore, shipments not complying with this proviso have been merely withheld from delivery until the lacking information has been supplied by the importer.

Institute of Metals To Meet in Liége

For the first time since 1913, The Institute of Metals will hold a meeting on the Continent. Arrangements have been made to meet in Liége, Belgium, from Sept. 1 to 4, at the invitations of the Association des Ingenieurs Sortis de L'Ecole de Liége. It is expected that the meeting will attract a large number of members from Great Britain and other countries, and G. Shaw Scott, secretary of the Institute has announced a provisional special party to leave London, Aug. 31, and returning Sept. 5.

"Successful Methods" Joins McGraw-Hill Group

With the June, 1926, issue *Successful Methods* will become a McGraw-Hill publication. This publication is a monthly journal which has been published for a number of years by Successful Methods, Inc., 141 Center St., New York City. It serves the construction field by short and succinct treatment, mainly pictorial, of the practical operations of construction. After June 1, 1926, the address of this magazine will be McGraw-Hill Publishing Company, Inc., Tenth Ave. at 36th St., New York, N. Y.

News from Washington

By Paul Wooton
WASHINGTON CORRESPONDENT OF *Chem. & Met.*

INDICATIONS at this writing are that the Muscle Shoals bill will not become a law at this session of Congress. A very determined effort is being made, particularly by Southern Senators, to secure a vote on the measure recommended by the Joint Congressional Committee. This attitude is influenced largely by the desire to secure distribution of the power for public utility use. They are joined by others who feel that it is a reflection on Congress not to make some disposition of this matter which has hung fire so long.

The fact that the Joint Committee of the Senate and House should have recommended the offer of the Associated Southern Power Companies came as a surprise to most members of Congress. There had been strong farmer support for the offer of the American Cyanamide Co. Further support for that offer came from those who feel Muscle Shoals can be used to the greatest advantage for chemical manufacture. It is very generally recognized, however, that the Joint Committee did a very good job of trading and has secured a bid from the power companies which it will be hard for any other bidder to meet, even were Congress to vote down the pending bill.

Terms of the Bid

The bid makes ample provision for national defense as the plant would be maintained in its present state of readiness for the manufacture of explosives. Moreover the premises and personnel may be taken over by the United States whenever necessary. Agriculture would be served by a definite program of fertilizer production. The fertilizer company agrees to produce annually 40,000 tons of nitrogen in the form of concentrated fertilizer, by means of synthetic ammonia and phosphoric acid plants, as follows: within three years, 10,000 tons annually of fixed nitrogen; within the succeeding three years additional ten thousand tons annually of nitrogen—total, 20,000 tons annually; thereafter, in succession, two additional units of 10,000 tons each annually, dependent on the sale for two consecutive years of such amount stipulated up to that time. Production beyond 40,000 tons annually is provided for but not guaranteed.

In addition to insuring an economic program of nitrate and fertilizer production the bid provides, during the 50-year lease period the largest monetary return to the United States of any of the bids considered. First, with the properties as they now stand without further expenditures by the United States; secondly, they provide larger financial returns for increased power at these properties due to upstream developments regardless of whether these latter are made by the United States or by other interests.

The fertilizer industry will not oppose the bill formally for fear that the motives of the industry would be misunderstood. At the same time it is felt that the legislation is very unfair to an industry which already is sinking from over-capacity. The public generally is more familiar with the coal industry than the fertilizer industry, it is pointed out. Were Congress to take action which would force the opening of new coal mines sufficient to increase production thirty per cent, the public would understand that this was not in their interest as they know that over-development is the unstable factor in the coal business.

There is no tendency to blame the power companies as it is recognized that they were forced into the fertilizer business. The fertilizer manufacturers feel that they have one thing for which to be thankful—the government did not go into the fertilizer business. Their competition is to come from private enterprise. While they contend it is subsidized, the present pending legislation is preferable to a government operation.

Representatives of the Muscle Shoals Fertilizer Co., which was formed by the thirteen Southern power companies submitting the offer, contend that Germany has emancipated Europe from the Chilean nitrate monopoly through the manufacture of the synthetic substitute. Since Germany is having no difficulty in disposing of more than 400,000 tons of nitrogen, they feel that the fertilizer manufacturers should not be alarmed because an ultimate production of 40,000 tons probably will result from this legislation. The reply made to that contention is that Germany can act in an arbitrary manner and preclude imports of Chilean nitrate, thereby forcing its farmers to use synthetic nitrogen. In the United States such an embargo is out of all question. The farmers have shown a decided preference for the natural product and will be very slow to change to other forms of nitrogen. This means, it is feared, that the Muscle Shoals production will have to compete directly with the mixed fertilizers being manufactured domestically.

The Muscle Shoals Fertilizer Co. has no intention of utilizing Plant No. 2. It expects to build Haber plants from the ground up.

Government research on the problems met in the manufacture and utilization of charcoal has been recommended by the sub-committee on wood chemicals of the National Committee on Wood Utilization.

Additional scientific research on the utilization of wood tar, non-condensible gases and other products derived from the distillation of wood, also was recommended. Some of these products are burned or otherwise wasted, while others are not utilized in the most efficient manner. "It is believed that government facilities are best adapted for this character of research," says W. Z. Giorgia, President of the National Wood Chemical Association, reporting for the sub-committee, "and it is recommended that wherever similar private research is now being carried on that it be co-ordinated with federal activities in order that the greatest general good may result."

Hearing on Vegetable Oils

A public hearing in connection with its investigation into costs of producing certain vegetable oils, under the flexible tariff provision as the result of applications for reductions in duties, will be held by the Tariff Commission May 25. At the same time, the commission will hear further arguments in connection with the petition of farm organizations that agricultural costs of producing the raw materials be considered.

In preparation for the public hearing, the commission has issued a preliminary statement of information as to the results of its field investigations, which have been in progress more than a year. So voluminous are the data that they are presented in printed form, and in two parts, the first devoted to costs of production, in connection with the computation of which certain questions are raised by the commission for discussion at the hearing, and the second part devoted to an economic study of the trade, prices, and interchangeability of oils and fats.

Cost data as presented in the preliminary statement are not exactly comparable as between the various countries because of differences in qualities and other factors. But on the face of the data, the cost of producing coconut oil is lower in the United States than in Holland or British India and higher than in the Philippines. The cost of producing cottonseed oil is higher in the United States than in Great Britain or in China, on the face of the figures; the cost of producing peanut oil here is higher than in China, but lower than in France or Great Britain; while in the case of soya-bean oil, costs in the United States are the highest, as compared with China-Manchuria, Japan and Great Britain.

Dr. Arthur von Weinberg, research director of the Cassella Co. and an important figure in the German chemical industry, was a recent visitor in Washington. He is said to have admitted that the American tariff wall is too high to scale. It is believed that Dr. Weinberg is investigating the possibilities for the exploitation of German patents and processes in this country.

It is believed that the Grasselli Co. will expand its operations in co-operation with the Hoechst Farbwerke and possibly may draw on other members of the I. G. for patents and chemical specialists. In addition, there are rumors that certain processes are to be exploited by the General Electric Co., by the Dupont Co., and by the Standard Oil Co. Dr. Weinberg's important connection with the I. G. and the fact that he is an authority on patents and specialized processes leads to the assumption that he is here in connection with some of the negotiations supposed to be in progress.

British Are Developing Dyestuffs for Coloring Concrete

Favorable Results Have Been Obtained in Preliminary Work and Wide Outlet for Dyes Is Promised

From Our London Correspondent

WHEN the Key Industries Duties were removed from gas mantles and also just prior to their reimposition some months ago, the British industry was gravely prejudiced by the large influx of continental mantles and it is satisfactory to report that the somewhat protracted negotiations with the German interests have at last proved successful, partly it is thought, because of higher production costs in Germany and partly on account of the more confident attitude of British producers with partial government support. Although the agreement is only for five years, important arrangements have been made in regard to the export markets and the arrangements appear particularly favorable to the British producers as regards their Empire markets, while of course, German importation to this country will cease. As regards the United States and Europe, those markets are now left to the German producers, an arrangement which is hardly likely to effect British interests.

Developments in the Dye Industry

The British Dyestuffs Corporation appears to be making satisfactory progress and recently acquired a controlling interest in Scottish Dyes, Ltd., of Grangemouth, where the production of vat dyes in this country is more or less centralized. No reliable information is obtainable in regard to the rumored negotiations with the German interests, although much capital has been made of the presence of the leading German industrialists, who have probably come to this country mainly to re-establish and consolidate their selling organizations, but possibly with the idea in the background that more delicate conversations with the British Dyestuffs Corporation might materialize. Good progress can also be reported in the Fine Chemical Industry and for instance, British Drug Houses, Limited, appear to be making satisfactory and substantial progress. On the other hand, chemical markets are by no means lively and there is as yet no decided upward trend in export business such as had been hoped for during the spring. One exception is the price of pitch, which has shown a marked increase from $7 to nearly $20 per ton and this may again revive interest in other binders for patent fuel and briquette manufacture.

Something of a sensation was caused by the report that Lever Brothers, Limited, would not pay a dividend on the ordinary shares this year, but the consequent fall in share values has not proved justified, the annual report disclosing an extremely sound position and showing that the passing of the dividend was solely for the purpose of consolidating and improving this great concern's financial resources.

Great interest has been aroused among large power concerns by the details that have now been released of the combustion steam generator developed by International Combustion, Limited, the first unit of which was installed near Manchester, the trials during the last few months having remained a closely guarded secret. The project of utilizing the salts and particularly the bromine content of the Dead Sea has again been revived and actually, the British Government is considering tenders and proposals in this connection.

Dyestuffs For Coloring Concrete

Very great interest has been aroused by the publication of preliminary details regarding the proposed use of dyestuffs for the coloration of concrete, cement and other building materials, using for this purpose dyestuffs instead of mineral earth colors or pigments. The technical work has been carried out under the direction of Dr. G. N. White, of London, and the results obtained are favorably regarded in competent quarters. The importance of this invention lies in the possibility of dyestuffs factories finding a further outlet, which may conceivably entail an increase in production of 100 per cent. The following details may be of interest and are extracted from a recent communication to the press:

"The new process employs those organic dyestuffs which have the greatest fastness to light, moisture, and other atmospheric effects, and which in the finished state are completely insoluble in water. The color range of such dyestuffs available for use in the building trade is very extensive, and there seems no reason why concrete should not now be tinted to produce any reasonable color scheme desired by an architect.

"The process is simple, and is equally applicable to the coloring of concrete for use in mass or as blocks. The concrete is gaged, not with water and the color in powder form, but with a solution of some simple derivation of the coloring matter. On exposure to the air, or by other simple treatment, the coloring matter is thrown down in a permanent insoluble form upon the cement particles.

"The difficulty in coloring concrete by means of pigment in powder form is to grind down the particles of pigment more finely than those of cement. If they are larger, the cement particles will cover them with a cement dust, and tend to produce a greyish effect. But the extreme fineness of cement makes it practically impossible to grind down any pigment into particles that are smaller than those of cement. If this could be done, a color effect might be obtained with the use of a much smaller quantity of pigment.

"This, however, is really the basis of the new process. By working with a solution of a derivative color or, in rather less exact language, a solution of the color, one actually employs the pigment in the most perfect state of sub-division possible. Although on precipitation there is doubtless a sort of coagulation, the precipitation occurs on the surface of the cement particles. The result is that quite a satisfactory depth of shade can be produced by the use of no more than .1 per cent to .6 per cent of coloring matter, calculated on the dry weight of the concrete.

"It is noteworthy that the depth of tint depends only on the ratio of dyestuff to cement; and, so long as this is constant, it is immaterial as far as the color is concerned, to what extent sand or other aggregate is added. Thus, a 7:1 mixture of sand and cement containing a .06 per cent of dye has practically the same depth of shade as pure cement containing .4 per cent of dye. This brings out very clearly the dependence of methods of coloring concrete upon the area of the particles to be colored, since the addition of, say, 86 parts of sand to 14 parts of cement increases the total particle area of the mixture by only some 5 per cent.

National Lime Association Will Meet in June

The eighth annual convention of the National Lime Association will be held at French Lick Springs Hotel, French Lick, Ind., June 8-11. The convention will be preceded by a meeting of the directors on Tuesday morning, June 8 and on the afternoon of that day the association will go into executive session. A tentative program has been arranged and among the speakers will be Irving I. Fellner, business manager of *Chem. & Met.*, who will speak on "The Market for Lime," R. P. Brown who will discuss "Balanced Publicity," L. B. Burt whose paper will be on "Opportunities in the Industrial Field." W. E. Carson, president of the Riverton Lime Co., will take for his subject "What is Wrong with the Lime Industry," J. S. Elwell will handle the topic "There is no Substitute" and G. J. Fink will discuss "The Practical Aspects of Research."

Ichthyol Production To Be Established in Texas

A new industry, designed to produce ichthyol, is being established near Burnet, Tex., and operations are slated to begin at an early date. A tract of land totaling about 900 acres has been leased for the project, comprising what is believed to be an ancient ocean bed pushed to the surface by geological action. The bed consists of fossilized remains of prehistoric fish, producing a particular shale from which ichthyol is extracted. This substance is literally a fossil fish oil employed largely in medicine, especially in ointments and in the treatment of skin diseases. In time past, the bulk of the world's supply has come from the Austrian Tyrol, where the industry was a flourishing one prior to the World War. With the Burnet deposit, the shale lies close to the surface and the overburden of earth will be removed with steam shovels.

Demand for Activated Carbon Gains Headway in France

Forced Debenzolizing of Coal Gas Opens Way for Large Consumption of Carbon at Gas Works

From Our Paris Correspondent

RECENT decrees by the French government compelled two of the most important gas producers of this country to debenzolize their entire production of coal gas. It is believed that, sooner or later, all the gas plants of France will be forced to follow a similar course and this has served to draw attention to the use of activated carbon prepared by the process of Edouard Urbain.

The absorbing properties of carbon treated with phosphoric acid are well known. Before the war Fr. Baeyer & Co. had turned out such a product from peat with a very low ash content. Carefully dried, then crushed and mixed with a solution of phosphoric acid, this peat was forced through a draw-plate and finally dried at 500 to 600 deg. C. The excess phosphoric acid was removed by washing and the mass obtained was again dried. When thus prepared the carbon can absorb 30 per cent of benzol. After absorption it is exposed to a jet of steam and the benzol thus removed.

Certain improvements are embodied in the Urbain process. He dries the carbon at 500 to 600 deg. C., adds impure natural phosphate and calcines at 1,200 deg. C. At this temperature the carbon reduces the phosphoric acid so that phosphorus finally is produced. Since there is a very restricted market for phosphorus, it is not collected but is burned to produce pure phosphoric acid. The calcined carbon is washed with muriatic acid which dissolves the remaining trace of mineral matter. It, then, is dried at 300 deg. C. before being packed in casks.

In brief the process starts with impure natural phosphates containing impure phosphoric acid and produces pure phosphoric acid, giving activated carbon as a byproduct. By varying the proportions of phosphoric acid, the temperature, and the duration of calcination, activated carbon is obtained, the absorbing capacity of which will vary between 5 per cent and 70 per cent in terms of benzol absorbed. Industrial uses for activated carbon are numerous, the most important being the debenzolizing of illuminating gas. The society L'Union De Gaz is erecting a plant at Nanterre near Paris where 2,800,000 cu.ft. of gas per day will be treated. The society Le Gaz de Paris when ready will treat 35,000,000 cu.ft. per day and the gas plant for the suburbs will treat about an equal quantity.

Urbain's activated carbon has an important use as a decolorizing agent in sugar-plants where it can advantageously be substituted for bone-black. The consumption of the latter in French sugar plants reaches 10,000 tons per year. At present there is only one plant in France for the making of activate carbon by the Urbain process. This plant is situated at Givors near Lyons and its producing capacity is 6 tons of activated carbon per day.

Interesting trials to acclimate the camphor-tree have been made in Algeria. Artificial camphor, as is well known, differs from natural camphor, and only the latter is authorized by the French pharmacopoeia to be utilized for pharmaceutical purposes. Now the consumption in France of pharmaceutic camphor is 200 tons per year while that of industrial camphor reaches about 1,000 tons. Results obtained so far in Algeria suggest that France may become independent of the Japanese monopoly if this cultivation is conducted on a large scale but it is a large undertaking and about 30 years would be required to give a plentiful yield.

The development of the production of nitrogen in France draws the attention to all special processes capable of industrial realization. One of these is the process patented by Camille Deguide (French patent No. 591,019), which utilizes barium cyanide. A start is made with a mixture of barium carbonate, coal, and, if necessary, a barium silicate. By the rotation of the oven the mixture progresses in one direction while nitrogen is introduced from the opposite end, the retort being heated to 1,200 to 1,300 deg. C. In the second stage of the process, superheated steam acts on the barium cyanide to produce ammonia.

Georges Claude speaking at the Academy of Science mentioned that the French plants using his process had during 1925 produced 10,000 tons of nitrogenous fertilizers. He added that for 1926 he hoped the production of the Claude plants to be 60,000 tons.

The trade agreement between France and Germany referred to in our previous correspondence has been extended. There are some products for which the quantities allowed have been exhausted. These quantities have therefore been raised especially for sodium chromate and bichromate for which a new contingent of 125 tons has been granted. Among new chemical products authorized to be imported in France under favored conditions are Epsom salt and synthetical tanning extracts.

Phosphate Production Planned for British Columbia

Phosphates to fertilize the wheat fields of the Canadian prairies will soon be produced in large quantities in British Columbia if plans now being considered by the Consolidated Mining and Smelting Co. are carried to fruition. Large deposits of phosphate have been discovered in recent years in the Kootenay districts of British Columbia and as a result of legislation passed at the last session of the provincial legislature it is possible for large concerns, ready to go ahead with development work, to stake out claims one square mile in extent. Previously it was not possible for claims larger than a few acres to be staked out, and under such conditions profitable operations were said to be out of the question.

Large Hydro-Electric Paper Plant for Canada

One of the most important of recent developments in the pulp and paper field in Canada was the incorporation of the Spruce Falls Power and Paper Co., Limited, which will build and operate a large hydro-electric paper plant, and pulp and paper mills near Kapuskasing, Ontario, about 60 miles west of Cochrane.

The full development of the enterprise involves an investment of $25,000,000, the daily production of 500 tons of newsprint and upwards of 120 tons of sulphite; also the development of power at Smoky Falls and Devil Rapids, which are situated about 40 miles north of Kapuskasing.

J. H. Black, general manager of the Spruce Falls Co., which now operates a sulphite mill at Kapuskasing, authorized the statement that the Kimberley-Clarke Co. of Neenah, Wisconsin, owners of all the capital stock of the Spruce Falls Co., has entered into an agreement to transfer all of the assets of the latter company to the Spruce Falls Power and Paper Co., and have also entered into an agreement with the New York Times Co., whereby on the transfer of the said assets of the Spruce Falls Co. Ltd., they will become jointly interested in the new company.

Larger Production of Aluminum Salts in 1925

The production of aluminum salts in the United States in 1925 was 335,480 short tons, valued at $13,155,790, according to statistics compiled by James M. Hill, of the Bureau of Mines. This compares with production in 1924 of 302,190 tons, valued at $9,301,410.

The aluminum salts industry consumed 122,340 long tons of bauxite in 1925, as compared with 106,150 tons in 1924. There was also consumed 440 tons of aluminum metal, which was used in the manufacture of alumina hydrate.

ALUMINUM SALTS PRODUCED IN 1925

Salt	Number of Producers Reporting	Short Tons	Value
Alum:			
Ammonia	5	4,750	$308,750
Sodium	4	14,450	838,100
Alumina, calcined and hydrate	4	4,490	321,850
Aluminum chloride, anhydrous and hydrate	4	12,830	4,012,920
Aluminum sulphate:			
Commercial—General	14	276,210	6,905,250
Municipal	6	6,240	129,600
Iron-free	7	16,140	613,320
Other aluminum salts	..	370	26,000
	..	335,480	13,155,790

Exports of aluminum sulphate in 1925 amounted to 20,756 short tons, valued at $505,537, as compared with 16,012 tons, valued at $407,749, in 1924.

Plans Series of Books on Chemical Engineering

Publisher Announces Program for Comprehensive Literature on All Phases of This Subject

Evidence of recent progress in the teaching and practice of chemical engineering is to be seen in the announcement during the past month of plans for a comprehensive series of reference and text books dealing with the various phases of chemical engineering. The lack of an adequate literature in this field has been a considerable handicap to the profession in the past and it has doubtless contributed to the lack of agreement among certain educators regarding the proper training and experience for the chemical engineer. Lately, however, the recognition of chemical engineering as a definite branch of engineering, has emphasized the need for a well-planned and correlated series of text and reference books that might serve both in the teaching and practice of the profession.

The tentative program announced by the publishers includes a considerable number of separate texts on various phases of chemical engineering theory and practice, supplemented by two series of monographs—one dealing with the so-call unit processes or operations, and the other a series of industrial monographs on the separate chemical engineering industries.

The principal books now planned or in the process of completion comprise the following: (1) Elements of Chemical Engineering (an elementary introduction to the subject). (2) Principles of Chemical Engineering (a mathematical and more advanced treatment). (3) Industrial Stoichiometry (a study of chemical calculations of manufacturing processes by W. K. Lewis and A H. Radasch, which has just been published). (4) Thermodynamics of Chemical Engineering. (5) Chemical Engineering Handbook (reference data contributed by numerous specialists). (6) Industrial Chemistry. (7) Industrial Application of Chemical Reactions. (8) Chemical Engineering Manual. (9) Materials of Construction for Chemical Engineering Equipment. (10) Chemical Plant Design. (11) Mechanical Control of Chemical Engineering Operations. (12) Chemical Engineering Economics (manuscript of this work now being prepared by Tyler of the staff of *Chem. & Met.*). (13) Marketing of Chemicals (market studies of chemical commodities and related groups of chemicals contributed by market authorities and edited by members of the staff of *Chem. & Met.*).

The chemical engineering series will be published by the McGraw-Hill Book Co., of New York, under the direction of the following committee of chemical engineers: L. H. Baekeland, President, Bakelite Corporation; Harry A. Curtis, Professor of Chemical Engineering, Yale University; J. V. N. Dorr, President, The Dorr Co.; D. D. Jackson, Executive Officer, Department of Chemical Engineering, Columbia University; J H. James, Professor of Chemical Engineering, Carnegie Institute of Technology; W. K. Lewis, Professor of Chemical Engineering, Massachusetts Institute of Technology; Arthur D. Little, President, Arthur D. Little, Inc., Consulting Chemical Engineers; R. S. McBride, Consulting Engineer-Chemist; Charles L. Reese, E. I. du Pont de Nemours Co.; H. P. Talbot, Massachusetts Institute of Technology; W. H. Walker, Consulting Chemical Engineer; E. R. Weidlein, Director, Mellon Institute of Industrial Research; M. S. Whitaker, Vice-President, U. S. Industrial Alcohol Co.; and A. H. White, Professor of Chemical Engineering, University of Michigan. The chairman of the committee and consulting editor for the series will be H. C. Parmelee, editor of *Chem. & Met.*

Domestic Production of Pyrites Increased in 1925

The production of pyrites in the United States in 1925 amounted to 170,081 long tons, valued at $650,448, according to figures compiled by the Bureau of Mines. This is an increase of 6 per cent in quantity, but only 1 per cent in value, as compared with the 1924 output, which was 160,096 long tons, valued at $645,262. The quantity of pyrites sold and consumed by producing companies also increased 6 per cent, or from 160,075 long tons in 1924 to 170,298 long tons in 1925. In 1925, as in 1924, the pyrites production was made in California, New York, Ohio, Virginia, and Wisconsin. The combined production of California and Virginia was 163,773 tons, 96 per cent of the total for the country.

News in Brief

Synthetic Ammonia in England—Consul M. L. Stafford reports from London that the United Alkali Co. has arranged to adopt the Casale process for the synthetic production of ammonia. It is understood that the company has no present intention to manufacture for the competitive market, but only for its own requirements both for ammonia as such and for the nitric acid produced by the catalytic oxidation of ammonia. During 1924, the last year for which detailed statistics are available, Great Britain imported 2,701 cwt. of anhydrous ammonia of which 2,255 cwt. were from the United States.

Larger Plant for Canadian Paper Company—By reason of a change in the construction programme, of the Thunder Bay Paper Company, a much larger plant than orginally intended is to be built at Port Arthur, Ontario. The new plans call for the construction of a 400-ton newsprint mill to be in operation before January 1, 1931, and to employ 750 men, in place of the 200-ton mill decided on at the beginning of the year.

American Leather Chemists Will Meet in June—The American Leather Chemists Association will meet at the Hotel Traymore, Atlantic City, N. J June 2-4. Following are some of the papers to be presented. Prof. Robert C. Gowdy will address the meeting on "Modern Views of Atomic Structure," J. A. Wilson will give a paper on "Properties of Shoe Leather," Prof. McLaughlin's Department of Leather Research at the University of Cincinnati will give four papers on the "Bacteriology of Goat Skin Soaking," "Further Notes on Animal Skin Fat," "Micro Tannology," and "Sheep Skin Preparation." Allen Rogers will speak on "Cresylic Acid for Tannery Use," B. N. Mathur on "Theory of Oil Tannage," A. W. Thomas on "Chemical Nature of Vegetable Tanning," M. W. Kelly on "Nitrogen Content of Hide Substance."

Committee from Industry to Aid New Course at M. I. T.—President S. W. Stratton of the Massachusetts Institute of Technology has appointed the following as a committee from industry to advise on the new course in gas and fuel engineering established this year: W. R. Addicks, Vice-Pres., Consolidated Gas Company of N. Y.; A. M. Barnes, Pres., Cambridge Gas Light Co., Cambridge, Mass.; Walter Barnum, Pres. Pacific Coast Coal Co.; D. D. Barnum, Pres. Boston Consolidated Gas Co.; H. L. Doherty, Pres. H. L. Doherty & Co.; F. A. Howard, Vice-Pres. Standard Development Co.; J. B. Klumpp, Vice-Pres. United Gas Improvement Co.; Fred R. Low, Editor of *Power*, McGraw-Hill Pub. Co.; R. M. Searle, Pres., Rochester Gas and Electric Corp.; W. E. Steinwedell, Sec., Gas Machinery Co., and T. R. Weymouth, Pres., Iroquois Gas Company.

German Bromine Syndicate Expires in June—The German Bromine Syndicate which was formed in September, 1925, expires June 30, subject to renewal. Bromine is obtained in Germany as a by-product of the potash industry and with the new Kaiseroda works of the Wintershall in a position to supply large quantities of bromine at a lower cost of production than that of other producers, the renewal of the Syndicate will in all probability depend on the attitude of the Wintershall firm. The syndicate prices range from 2.50 to 3.00 marks per kilo while production costs of the Wintershall are reported to be approximately 50 pfennigs per kilo. The 1926 production of bromine in Germany promises to be a record having been estimated at 1,800 metric tons.

Chemical Salesmen Will Hold Annual Outing—The Salesmen's Association of the American Chemical Industry will hold their annual seashore outing on May 22. On June 4 the association will hold its spring golf tournament at the Westchester Hills Golf Club.

Du Pont Powder Mill Developments—E. I. du Pont de Nemours & Co., Wilmington, Del., are arranging for the early dismantling of their fuse works at Pompton Lakes, N. J., and will erect a new blasting cap plant at the same location. The new plant will consist of a group of 15 or 20 buildings, estimated to cost close to $250,000, with equipment. The company is demolishing its powder plant at Haskell, N. J. Arrangements have been made for the dissolution of the E. I. du Point de Nemours Powder Co., a New Jersey corporation, inactive for some time. The operations and business of this company have been taken over by the parent organization of E. I. du Pont de Nemours & Co.

Men You Should Know About

At the annual meeting of the AMERICAN INSTITUTE OF CHEMISTS, held on May 8, in New York, the following officers were elected: President, Treat B. Johnson; vice-president, Lloyd Van Doren; Secretary, L. R. Seidell; Treasurer, Clarence K. Simon. The following were elected Councillors at Large:

Treat B. Johnson

Horace G. Byers, Hugh B. Gordon, Calm M. Hoke, Matthew A. Hunter, James Kendall, Ralph E. Lee, Albert P. Sachs and William Walker.

JOHN HAYS HAMMOND, in honor of his 71st birthday, was tendered a dinner in New York, May 3. Felicitations by telegraph, cable and mail were sent by the President of the United States, the governors of ten states, twenty ambassadors and foreign ministers, railroad presidents, generals and admirals, as well as messages from Luther Burbank, Vice-president Dawes, Cardinal Hayes, Mayor Walker of New York and Chief Justice Taft. C. S. Thomas, former U. S. Senator from Colorado presided, and the speakers were Dr. A. T. Hadley, J. J. Davis, Dr. Alexander C. Humphreys, Key Pitman, Col. Henry D. Lindsay, J. W. Bryan and Rev. J. E. Freeman. At the same time dinners were also held in Mr. Hammond's honor in South Africa, Japan and in many European and American cities.

CARL B. ELY, president of the Tannin Corporation, New York, sailed early in May for a trip abroad. He will be absent for several weeks.

M. R. WALCZAK, heretofore chief chemist for The Barrett Co., in charge of production at plants in the Chicago district, has been transferred to the general manufacturing division at New York, where he will act as assistant planning supervisor.

WALTER S. CARPENTER, JR., vice-president of E. I. duPont de Nemours and Co., Wilmington, Del., has been elected vice-chairman of the executive committee of the company succeeding Lammot duPont, recently elected president and chairman of the committee.

DR. RICHARD MOLDENKE, of Watchung, N. J., metallurgist, is planning a trip to Honduras in the near future. He recently returned from a visit to Europe.

C. WILLIAM SCHWENZRIER, for the past 15 years connected with the Owens Bottle Co., at its Glassboro, N. J., plant, has recently been advanced to the position of supervisor of factories of the company, with headquarters at Toledo, Ohio.

BLAINE S. SMITH, connected with the Universal Portland Cement Co., Chicago, Ill., since 1908, in various capacities, has recently been elected vice-president of the company. He is also president of the Portland Cement Association.

EDGAR W. RICE has become chief chemist for the National Sugar Refining Co., New York. He has been connected with the company for the past 16 years.

J. EARL FRAZIER, heretofore chief chemist with the Berney-Bond Glass Co., Clarion, Pa., has resigned to become chemical engineer for the Simplex Engineering Co., Washington, Pa.

J. C. VOORHIES of Brooklyn, N. Y., has recently resigned his connection with the Hazel-Atlas Glass Co., Wheeling, W. Va., to engage as a consulting engineer in the line of glass manufacture.

GEORGE A. BEATTY has become chemist for the Canada Dry Ginger Ale Co., Hudson, N. Y., in charge of extract and syrup production. He recently resigned a connection with the Mathieson Alkali Works, Niagara Falls, N. Y.

R. R. DANIELSON has resigned as chief chemist at the enameling works of the A. J. Lindemann & Hoverson Co., Milwaukee, Wis.

R. N. MILLER, a member of the pulp and paper staff of the United States Forest Products Laboratory, Madison, Wis., since 1921, engaging largely on sulphite investigations, has resigned to become connected with the Paulista Railway Co., Sao Paula, Brazil. His initial work will cover a survey of eucalyptus plantations at Rio Clara with view to possibilities of pulping such wood for newsprint production.

C. A. HIGHT has been elected president of the U. S. Smelting & Refining Co., New York, to succeed C. G. Rice, who has been elected chairman of the board of directors. Mr. Hight has heretofore been vice-president of the company.

DR. HERBERT H. DOW, president and general manager of the Dow Chemical Co., Midland, Mich., has returned to his home after a 3 months' trip abroad.

J. E. MORROW has resigned as chemical supervisor with the Pennsylvania Salt Manufacturing Co. to accept a position in the research bureau of the Aluminum Company of America.

E. P. JAQUES, formerly with Peet Brothers Co., has accepted a position in the raw materials group of the Development Branch of the Western Electric Co., Chicago, Ill.

DR. C. K. FRANCIS, formerly vice-president in charge of manufacturing for the Producers and Refiners Corporation, and recently engaged in consulting work in Tulsa, Okla., has been appointed technical editor of the *Oil and Gas Journal*.

C. K. MCARTHUR joined the staff of The Dorr Co. on May 1. He was for a number of years connected with the Consolidated Mining and Smelting Co., Trail, B. C. He was at one time with the Butte and Superior Mining Company and more recently with the Timber Butte Company, Butte, Montana.

GRINNELL JONES, professor of industrial chemistry, Harvard University, and who since 1921 has served in an advisory capacity on chemical matters for the U. S. Tariff Commission, has resigned from this connection and will continue consulting work on the economic phases of the chemical industries.

FRANCIS R. PYNE is now superintendent of the Raritan Copper Works, Perth Amboy, N. J.

B. R. TUNISON, for several years in charge of sales development work for the U. S. Industrial Alcohol Company and active in matters relating to the alcohol and solvents industries, has been appointed vice-president in charge of sales for the recently organized American Solvents and Chemical Corporation, with headquarters in New York City.

Photograph by Bachrach

B. R. Tunison

DR. CHARLES W. HILL has resigned the position of general works manager of the Atlantic Terra Cotta Co., Perth Amboy, N. J., and has been appointed assistant manager of the Peter Cailler Kohler Swiss Chocolate Co., at Fulton, N. Y.

DALTON M. GOETSCHIUS, who has been employed in process research and development for the Standard Chemical Company Company at their Canonsburg, Pa., plant, and for some months has been doing similar work for the Radium Dial Company of Pittsburgh, has been made superintendent of the latter company's establishment at

Streator, Ill. Before coming to the Pittsburgh district in 1920, Mr. Geotschius was chemist and works manager for L. Feuchtwanger and Co. of New York City and Little Ferry, N. J.

DR. M. SEM, a representative of the Norwegian company, Det Norske A/S for Elektrokemisk Industrie, Oslo, which company holds the patents for the Soderberg selfbaking electrode, has returned to this country, and is staying at the Hotel Commodore, New York.

DR. GUSTAVUS J. ESSELEN, JR., of Skinner, Sherman and Esselen, Inc., industrial chemists, Boston, recently delivered the last of the series of three John Howard Appleton lectures for this year at Brown University, Providence, R. I. His subject was "Cellulose Chemistry as Applied to Rayon."

ANDREW M. FAIRLIE, chemical engineer of Atlanta, Ga., is the author of new texts on the manufacture of sulphuric acid, published by the International Correspondence Schools of Scranton, Pa.

NORMAN INTO has left the Dorr Co. to join the American Cyanamid Company, New York. He is in the Commercial Dept.

CHAPLIN TYLER, assistant editor of *Chem. & Met.*, has been appointed to be associate in journalism in Columbia University. He will conduct the course in industrial paper journalism in the Joseph Pulitzer School.

DR. F. G. COTTRELL, director of the Fixed Nitrogen Research Laboratory, is in Europe to familiarize himself with the progress being made in nitrogen fixation in various countries there. During his absence Dr. S. C. Lind is acting as director of the Laboratory.

L. F. HOYT, for eleven years associated with the Larkin Co., Inc., Buffalo, N. Y., and head of the research department for several years, has resigned to accept the position of assistant chemical director in charge of control work at the duPont Rayon Co., of Buffalo, N. Y.

Obituary

JOHN L. MALM, chemical and metallurgical engineer of Denver, Colo., died at his home in that city April 25 after a week's illness. Mr. Malm was born at Titusville, Pa., Oct. 2, 1874. He was educated at Central High School and Case School of Applied Science in Cleveland, graduating from the latter in 1897. His first engineering experience was in the development of iron ore deposits in Michigan. Later he turned his attention to the precious metals and spent considerable time in the cyanidation of silver and gold ores in Mexico. In 1904 he went to Denver where he developed a dry chlorination process for the treatment of low-grade and complex ores of Colorado and other Western States. In addition to his technical activities he took a lively interest in community affairs. He was prominent in the Denver Chamber of Commerce, was chairman of the Community Chest of Denver and was deeply interested in the work of the Boy Scouts. Near East Relief and similar matters always had his active support. He is survived by his widow, one daughter and six sons.

ARCHIBALD P. RAMAGE, treasurer and general manager of the Mississquoi Pulp and Paper Co., Sheldon Springs, Vt., died April 29 at his home in Northampton, Mass.

NORMAN GRANT, vice-president and assistant general manager of the Federal Terra Cotta Co., New York, died recently. He was one of the pioneers in the terra cotta industry, devoting practically his entire career to this line. Following a connection with the Atlantic Cotta Co., New York and Tottenville, S. I., which he organized with his brother, DeForest Grant, he formed, with his brother, the Federal Terra Co., in 1909, engaging continuously with this company since that time.

JOHANNES SCHMEDTJE, St. Louis, Mo., for many years vice-president and general manager of the Adolphus Busch Glass Mfg. Co., of that city, died at his local residence, April 17, aged 75 years. He retired from active business in 1920.

CLARENCE W. COLLINS, vice-president of the Cherry River Paper Co., Richmond, Va., died suddenly at Hollywood, Los Angeles, Cal., April 12, as a result of a heart attack. He was 53 years of age, and was extensively identified with the paper manufacturing industry.

Calendar

AMERICAN CHEMICAL SOCIETY, regional meeting, Madison, Wis., May 28 and 29. The section on Paint and Varnish Chemistry and the Division of Cellulose Chemistry, will also hold meetings at the same time.

AMERICAN CHEMICAL SOCIETY, Philadelphia, Pa., Sept. 3 to 8.

AMERICAN ELECTROCHEMICAL SOCIETY, Washington, D. C., Oct. 7, 8 and 9.

AMERICAN INSTITUTE OF CHEMICAL ENGRS., Berlin, N. H., June 21-24, 1926.

AMERICAN LEATHER CHEMISTS ASSOCIATION, 23rd annual meeting, Hotel Traymore, Atlantic City, N. J., June 2-4.

AMERICAN ELECTROPLATERS SOCIETY, convention, Salaam Temple, Newark, N. J., June 28-July 1.

AMERICAN GAS ASSOCIATION, Eighth annual convention and exhibition, Atlantic City, N. J., Oct. 11 to 15.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, spring meeting, San Francisco, Calif., June 28 to July 1.

AMERICAN SOCIETY FOR TESTING MATERIALS, annual meeting, Atlantic City, N. J., June 21 to 25.

CANADIAN CONVENTION OF CHEMISTS, under the joint auspices of the Society of Chemical Industry and the Canadian Institute of Chemistry, Montreal, May 31, June 1 and 2.

COLLOID SYMPOSIUM (Fourth Annual), Mass. Inst. of Tech., Cambridge, Mass., June 23 to 25.

NATIONAL FERTILIZER ASSOCIATION Green Brier, White Sulphur Springs, W. Va., June 7-12.

NATIONAL LIME ASSOCIATION, Eighth annual convention, French Lick Springs Hotel, French Lick, Ind., June 8-11.

SESQUI-CENTENNIAL INTERNATIONAL EXPOSITION, Independence Sq., Philadelphia, Pa., June 1 to Dec. 1.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, annual meeting, State University of Iowa, Iowa City, Ia., June 16 to 18.

SOUTHERN EXPOSITION (2nd Annual), Madison Sq. Garden, N. Y., Oct. 2-10.

Industrial Notes

THE ROLLWAY BEARING COMPANY, INC., Syracuse, N. Y. announces the following changes in personnel in the sales force: C. A. Call, formerly assistant sales manager, Gurney Ball Bearing Company has been appointed sales manager; E. J. Lybert, formerly representing the Rollway Company in the Philadelphia district, now takes charge of the Detroit district; J. D. Firmin, for many years associated with the engineering department of Niles-Bement-Pont, is now engineering representative in the Philadelphia district; W. E. Smith has been transferred from the home office to the Youngstown district, where he will assist Samuel Farrell, district representative, and S. J. Kaiser continues to represent the company in the Chicago territory.

THE AMERICAN SOLVENTS AND CHEMICAL CORPORATION was recently organized as the result of a merger of the following corporations: Everett Distilling Co., Everett, Mass., Jefferson Distilling and Denaturing Co., Harvey, La., Crescent Industrial Alcohol Co., New Orleans, La., Western Industries Co., Agnew, Calif. and Witbeck Chemical Corporation, Albany, N. Y. The new corporation will engage in the manufacture and sale of the solvents and chemicals formerly handled by the individual companies. It is stated that the pooling of the individual experience, development, processes and patents contribute to the solvent consuming industries marked economies as a result of the combined efforts of the corporation. The executive officers of the corporation, all of whom have been previously identified with large organizations in the alcohol and chemical industries, are as follows: President, H. I. Peffer; vice-presidents, A. P. Jell and B. R. Tunison; and secretary-treasurer, Lester S. Bacharach. The executive offices of the corporation are located at 285 Madison Ave., New York City.

THE ROBERT P. KEHOE MACHINERY CO., which has made a specialty of refrigerating and ice-making machinery, has recently acquired larger offices at 7 East 42nd Street, New York.

THE AACONE ENGINEERING CORP. is now located at Durham Ave. and Lehigh Valley R.R., Metuchen, N. J.

ZINSSER & CO., INC., Hastings-on-Hudson, New York, have united their business with that of The Ultro Chemical Corporation, of 1 Hudson Street, New York City. The affairs of both companies will be carried on under the name of Zinsser and Co., Inc., Hastings-on-Hudson. The officers are: President, F. G. Zinsser, vice-presidents, William Steinschneider and Herman Staber, and secretary and treasurer, J. S. Zinsser.

THE MATHIESON ALKALI WORKS, INC., or New York City, announces the appointment of William A. Field, as Chicago district sales manager, with offices at 310 South Michigan Ave., Chicago, Ill., and also the appointment of Frederick H. Lovenberg to take charge of a St. Louis district sales office. This company has also completed arrangements with the Fields Point Manufacturing Corporation of Providence, R. I., which will afford the latter corporation the general support and extensive resources of the Mathieson Alkali Works, for the benefit and service of the New England customers of both companies. Daniel Townend, president of the Fields Point Manufacturing Corp., will have charge of the sales of both companies' products, and the New England office will be maintained, as heretofore, at 911 Rhode Island Hospital Trust Bldg., Providence, R. I.

THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY have promoted J. McA. Duncan, for fourteen years Pittsburgh district manager and who has been with the company for forty years, to assistant general sales manager. It is also announced that H. F. Boe, formerly industrial division manager at Buffalo has been promoted to branch manager of that office, and R. L. Kimber to industrial division manager. W. F. Barnes is appointed branch manager of the Tulsa office of the company.

THE UEHLING INSTRUMENT CO. has appointed Henry Eggelhof, P. O. Box 945, Dallas, Texas, representative for the Eastern half of Texas.

THE SULLIVAN MACHINERY CO. of Chicago has moved its Knoxville office to the General Building, 623 Market Street.

Market Conditions and Price Trends

Sulphuric Acid Prices Will Be Higher

Preponderance of Sulphur Consumption Over Production Makes Price Advances a Logical Result of Existing Conditions

By Charles H. MacDowell
President Armour Fertilizer Works, Chicago, Ill.

AMERICA mined 1,220,561 tons of sulphur in 1924, and shipped 1,537,343 tons. 1925 production was 1,409,240 tons; shipments, 1,857,970 tons. Exports for 1924 were 482,114 tons; for 1925, 629,400 tons.

The Union Sulphur Co. ceased mining in 1924, and shipments since that time have been made from stock pile. Sicily decreased her stocks 135,000 tons in 1925. World's shipments the last two years have been 900,000 tons in excess of production. Long term sulphur contracts expiring recently are being renewed at higher prices. Today's market is 15-20 per cent below 1913-14 range, when little sulphur was used in the manufacture of sulphuric acid.

Acid prices will be higher, and products in the manufacture of which acid forms an important element will cost more to produce.

It is natural that a raw material having a world-wide distribution, catering to many essential needs, mined at only a few points and with consumpiton running ahead of production, should respond in higher prices.

No New Sources of Supply

No important new sources of sulphur supply are in sight. Unless new production comes into being, growing consumption of pyrite for chamber acid is inevitable, especially at coast and lake port plants, where imported ores can be obtained. Interior points will continue the use of sulphur as long as mine price and freight savings permit. These changes will come gradually, and will entail the installation of new pyrite burners. Makers of this equipment advise many recent inquiries.

Fertilizer chamber acid manufacturers can use pyrite more profitably and to a greater extent than can makers of contact and commercial strength acids, where purity of gas and of product is more essential.

Three-fifths of the sulphuric acid produced in the United States in 1915-16 was manufactured from Spanish pyrite, lump and fines. The remainder was secured from Canadian and domestic pyrite, pyrhhotite, brimstone, zinc and copper smelter fume. Submarine sinkings and necessary shipping diversions were rapidly reducing ore supplies from Spain. In February, 1917, in co-operation with the Bureau of Mines, an investigation of possible domestic sources of supply was started. Early in May, 1917, the Chemicals Committee of the Council of National Defense arranged with the sulphur miners to ship sulphur to fertilizer manufacturers when pyrite stocks were exhausted, at $22 a gross ton mine. Allocations covering two months' needs were made from time to time. This price was maintained during the war period and applied to all sulphuric acid producers manufacturing acid for munitions, chemicals, or fertilizer purposes. Few fertilizer acid plants were equipped with sulphur burners. A pamphlet was issued by the Chemicals Committee showing how existing pyrites equipment could be used for burning sulphur.

Sulphur stocks above ground at that time were in excess of one million tons. Production was materially increased during the war period, and this reserve stock was kept intact. Aggressive search for sulphide ores suitable for acid manufacture and convenient to transportation was kept up during the war period, especially by the Department of the Interior. A few minor deposits were located, but no important ore bodies were found.

It soon became apparent that brimstone was the only reliable source of war supply, and every effort was put forth by the War Industries Board to increase sulphur production. Engineers, machinery, workmen, transportation, could not wisely be diverted from war activities to the development of relatively small and unimportant pyrite ore bodies. Coal brasses (marcasite) found extensively in certain bituminous coal mining sections could be cleaned of attached carbon, but this meant increased mining, transport to central washeries, more machinery, extra labor, and at best a rather low grade material 40 per cent sulphur), reducing acid plant output through CO_2 dilution at a time when increased output was the order de jour. Early in 1918 permission was granted the now Texas Gulf Sulphur Co. to develop at their expense a sulphur deposit, drillings showing a large deposit of brimstone with good cover. This property came into production early in 1919.

The War Minerals Relief Committee appropriated large sums to compensate companies attempting to develop pyrite deposits during the war.

In early 1919 nearly all acid produced by the fertilizer industry was made from sulphur. When the new production entered the market, prices were fixed at a point where sulphur was favored in preference to pyrite. Manufacturers figured they could afford to pay several cents a unit more for sulphur than for pyrite, taking into consideration the saving in labor, larger yield from plants, increased flexibility in output, easier manufacturing control, and fewer hidden losses. A few coast plants continued burning Spanish fines. The use of lump ores was discontinued. Lump and fines burners were scrapped, and mechanical and pan sulphur burners installed.

If manufacturers decide to burn pyrites, much new equipment will have to be installed at a large total capital expense. The pyrite will come mostly from Spain's large deposits, although Cuba may later make offerings. Canada can supply a considerable tonnage for boat shipment to lake ports. Although the bituminous coal fields can furnish perhaps half a million tons of marcasite of 40 per cent grade for interior plants, it is unlikely, considering the demoralized condition of the coal industry and the comparatively low value of the product, that miners would undertake its salvage. Pyrhhotite, with clinkered iron ore as a byproduct, can be used at central points. When finely ground it burns reasonably well in modern equipment, but is too low grade for distant shipment. One or two Georgia pyrite deposits might be worked at a price, but no large tonnage could be expected from this source. While no data is available, sulphur reserves are thought to be large enough to provide a reasonably large tonnage for a good many years. This tonnage will naturally go to industries and to points where it works out best for the producers. This applies especially to interior points where high freight rates discourage the use of pyrite.

New Developments Affect Acid

New developments in certain industries are tending to reduce the use of sulphuric acid and sulphur. Fixed ammonia oxidized to nitric acid for munitions, commercial explosives and other nitrating ventures, is a case in point. The German method of using calcium sulphate in manufacturing ammonium sulphate is another. It is reported that a German concern is manufacturing 3,000 tons a month of 100 per cent sulphuric acid using gypsum as a source of sulphur, even though pyrite is available.

The electric furnace is successfully producing phosphoric acid for food and fertilizer purposes.

Calcining methods for rendering phosphoric acid available offer possibilities.

Western smelter acid as double superphosphate, using western rock, is invading the central west.

Thousands of tons of sulphur equivalent in sulphur fume is escaping daily into the air in the inter-Rocky Mountain-Pacific Coast and other sections. Some day, somehow, this sulphur will be recovered as such and enter into world's markets as an easily shipped and much needed material, adding to the gross—and let us hope, the net—receipts of the smelting companies. It is being accomplished now on a small scale at some of our coke and gas plants, and in a larger way from water gas purification at Germany's nitrogen fixation plants. Here is a serious worthwhile problem for the research chemist and for the heads of our smelter organizations.

Market Conditions and Price Trends

Larger Distribution of Chemicals In First Quarter of Year

Principal Consuming Industries Operated on More Active Basis Than They Did in Corresponding Period Last Year

WHILE reports of industrial activities for April indicated a falling off in operations in the paper, textile, leather, and other industries which offer outlets for chemicals, there are evidences that consumption of chemicals in the first quarter of the year was on a larger scale than was the case in the first quarter of 1925.

Taking as a basis for computation, the weighted index numbers for employment as compiled by the U. S. Department of Labor, it is found that the trades which are the largest consumers of chemicals were more active in March than they were in the preceding month. Exceptions are reported in the case of tire and petroleum refining trades. For the three-month period ended March 31, these consuming trades report substantial gains over the corresponding period of 1925. The figures offer the following comparisons:

Index of Employment

	March 1926	Feb. 1926	March 1925
Dyeing and finishing textiles	101.6	101.4	102.8
Leather	93.4	93.3	92.6
Paper and pulp	95.6	95.3	96.6
Chemicals	95.4	95.3	93.5
Fertilizers	153.1	122.2	137.4
Glass	100.6	97.2	92.7
Automobile tires	111.8	113.7	107.9
Petroleum refining	97.4	98.0	89.4

Average Index of Employment

First Quarter of Year

	1926	1925	1924
Dyeing and finishing textiles	101.5	101.5	91.5
Leather	93.1	92.3	95.2
Paper and pulp	95.3	94.4	96.9
Chemicals	95.3	92.5	99.2
Fertilizers	127.6	108.8	101.6
Glass	97.6	90.7	96.0
Automobile tires	112.7	105.6	93.1
Petroleum refining	97.7	89.3	92.9

In some instances the average index of employment for the first quarter of the year compare unfavorably with those for 1924 but it will be recalled that during that year there was an overproduction of finished goods and raw materials in the first quarter and this was followed by a long-continued period of retrenchment in all the industries specified with the exception of oil refining and automobile tires.

Based on monthly electrical energy consumption in large manufacturing plants *Electrical World* states that in the Middle Atlantic States, the chemical, paper, and leather industries reported substantial decreases in activity in April. In reporting on activities throughout the country the same authority states that the leather industry has further decreased its output, operations in April being 16 per cent under the monthly average for the last three years. The textile industry also was reported as having taken a downward turn in April with operations 7.2 per cent above the monthly average as compared with 14.6 per cent above the monthly average in the preceding month. In New England the decline in activity in the textile industry was considerably greater than for the country as a whole. The glass trade in April showed a moderate gain over operations in March.

Larger Production in March

According to the index number of the Department of Commerce, covering 64 commodities, manufacturing in March, after adjustment for differences in working time, at 130 per cent of the 1919 average showed no change from February but was 1 per cent higher than in March, 1925. The principal increases in March over February, due largely to the longer month, occurred in the production of foodstuffs, with a gain of 7 per cent, textiles, with a gain of 10 per cent, iron and steel products, with a gain of 17 per cent, non-ferrous metals, with a gain of 16 per cent, lumber, with a gain of 9 per cent, leather, with a gain of 13 per cent, paper and printing, with a gain of 13 per cent, chemicals and oils, with a gain of 2 per cent, stone and clay products, with a gain of 35 per cent, tobacco, with a gain of 9 per cent and the miscellaneous groups including automobiles, with a gain of 15 per cent.

The total output of raw materials showed no change from March, 1925, increases occurring in the output of minerals, animal products and forestry products balancing a decline in the marketing of crops.

Stocks of commodities held at the end of March, after allowance for seasonal variations, showed a decrease of 5 per cent from February and an increase of 3 per cent over March, 1925. Increases over a year ago occurred in the stocks of raw foodstuffs and raw materials, for manufacture while declines occurred in the manufactured foodstuffs and other manufactured commodities groups.

The index of unfilled orders showed decreases from February and a year ago. Unfilled orders for building materials showed no change while the iron and steel groups declined from March, 1925.

Chemical Index Lower

The majority of important chemicals held a steady price course throughout the past month. The weighted index number, however, shows a material decline. Continued weakness was found in the market for denatured alcohol but there are indications of a recovery as first hands are not quoting on distant positions. Declines in the metal market brought about downward revisions in prices for the lead pigments. Sulphate of ammonia also contributed to decline of the index number. Easier markets also were reported for other ammonia products with a similar condition in the market for antimony compounds. Sulphuric acid was firm and copper salts generally were higher than a month ago. The weighted number is now 11.64 as compared with 113.25 a month ago and 112.24 a year ago.

In marked contrast to the position of chemicals was the strength shown by the vegetable oil list and sharp upturn to the weighted index number for oils and fats. The number is 154.19 as against 149.09 a month ago and 153.13 a year ago. The most important factor in the uplift of values consisted in the rise in values for crude and refined cottonseed oil. China wood oil also was higher and crude corn oil was advanced sharply. Glycerine was more firmly held but tallow and greases showed an easier undertone.

A larger gain in imports than in exports characterized the United States foreign trade in chemicals and related products during the first quarter of 1926 as compared with the corresponding quarter of 1925. Imports rose 11 per cent from an aggregate value of $61,192,000 in January-March, 1925, to $68,345,000 in January-March, 1926, while exports rose only 4 per cent from $38,443,000 to $39,967,000. The March figure in each instance was the highest of the three months.

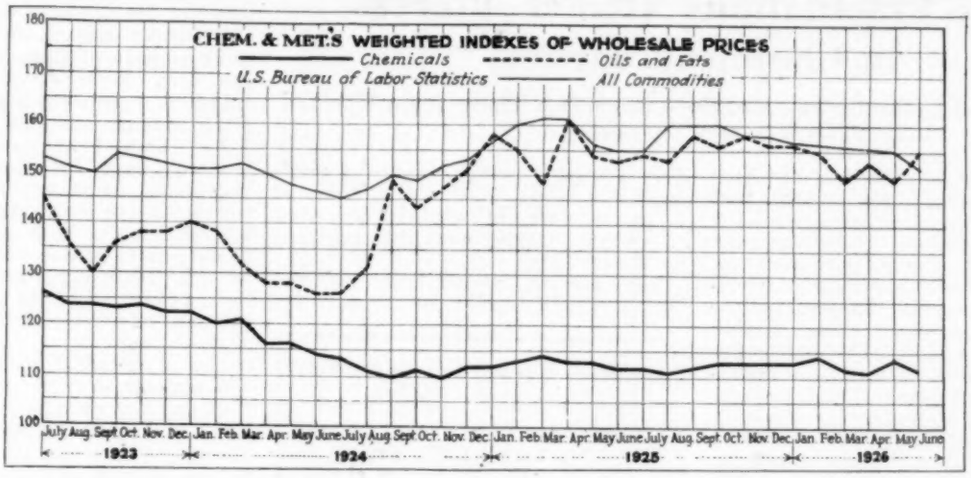
The differences in price of many commodities accounted for some of the changes, as is usual, but even then heavier shipments were made, on the whole, as evidenced by the larger quantity figures. The important increases affecting the grand total for imports occurred in the major groups—industrial chemicals, fertilizers, and gums and resins. In the exports, the gains recorded for the related products groups—naval stores and sulphur—partly offset the losses registered in some of the chemical classes.

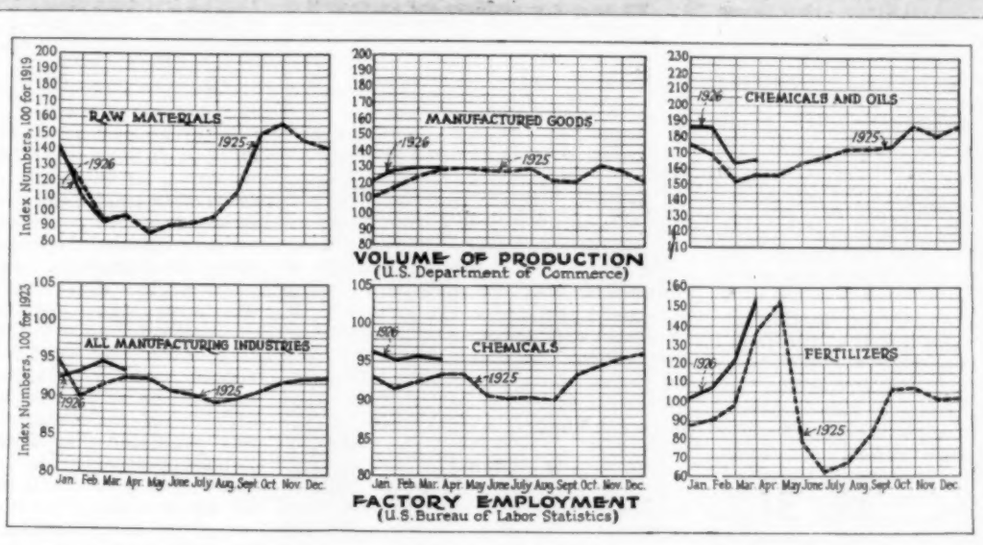
THE FERTILIZER INDUSTRY—PRODUCTION, CONSUMPTION, SALES, AND STOCKS OF SULPHURIC ACID: 6-MONTH PERIODS, JULY 1, 1924, TO DECEMBER 31, 1925.

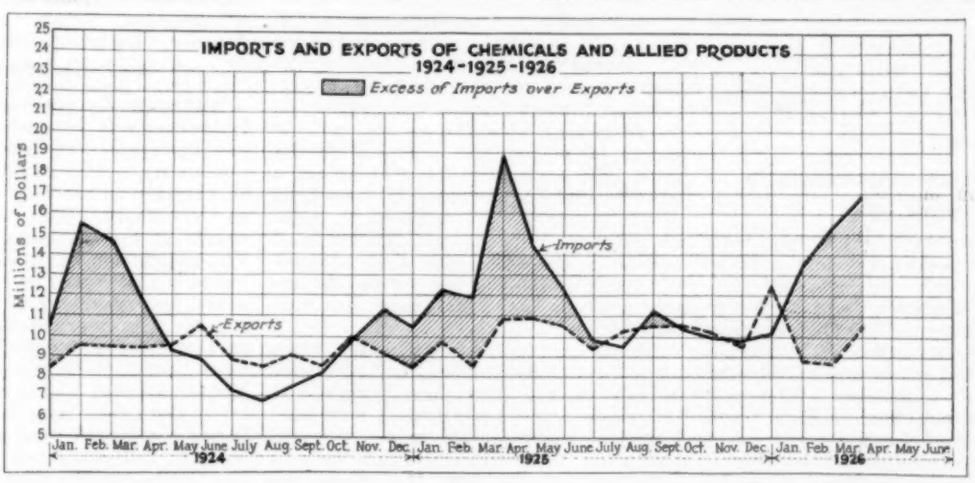
United States	1925 2nd Half July-Dec. Tons	1925 1st Half Jan.-June Tons	1924 2nd Half July-Dec. Tons	Per Cent of Increase 2nd Half 1924 to 2nd Half 1925
Stocks on hand at beginning of period	104,376	108,586	104,404	....
Produced in establishments reporting	955,084	855,338	779,370	22.5
Purchased	435,210	330,219	333,906	30.3
Total	1,494,670	1,294,143	1,217,680	22.7
Consumed in making fertilizers	1,122,025	971,984	895,915	25.2
Sales:				
To fertilizer works	181,368	128,700	143,619	26.3
To other than fertilizer works	90,815	93,473	68,901	31.8
Stocks on hand at end of period	100,462	99,986	109,245	— 8.0

Chem. & Met.'s *Statistics of Business*

In The Chemical Engineering Industries







Market Conditions and Price Trends

Price Fluctuations Attract Interest In Chemical Market

The Weighted Index for the Month Is Down But There Is an Upward Trend to Many Selections

SPOT trading in chemicals has been along moderate lines in the past month and contract withdrawals have been largely routine. There has been keen interest in the market, however, because of price changes or of probable price changes. Judged by the action of the weighted index number the trend of prices would be interpreted as downward but there is an underlying current of firmness which would indicate an early recovery in values.

Consumers of sulphuric acid have been inquiring about future values for that chemical. Rises in the sulphur market have carried signifiance to consumers of acid and answers to their inquiries in the present market have confirmed their fears that values for the acid will work to higher levels.

Weakness in denatured alcohol has been in evidence for some months but the future course of prices would hardly be regarded as downward in view of the fact that leading producers are not willing to accept current prices for later deliveries and in fact are reluctant to quote on contracts involving distant deliveries. The general impression is that values will appreciate in the near future.

There is considerable speculation relative to the demand which will be found for calcium arsenate. Under large accumulations of stocks values for white arsenic and calcium arsenate have declined to a point where further reductions are regarded as improbable. Any real buying movement, therefore, would have a stimulating effect on values for these commodities. Predictions regarding boll weevil damage to the cotton crop this season have given rise to the belief that arsenate will find a better market than it did last year. The potential market is large enough to create a shortage of both arsenic and arsenate if it should exert itself to the limit. The best that can be said, however, is that actual weevil damage must be awaited before any heavy buying sets in.

Important Developments in Potash Salts

Interest in potash salts has been heightened by recent developments in primary markets. Of greatest importance was a report from Berlin to the effect that the Franco-German potash agreement had been extended. This was verified by reports sent to the Department of Commerce. The new agreement became effective May 1 and covers a period of 7 years.

The general provisions of the May 7, 1925, pact are to be continued, with the division of the world's market on a basis of 70 per cent for German producers and 30 per cent for the Alsation. This spread, however, is to be gradually diminished until a final basis of 50 per cent for each country is arrived at, which, it is expected, will be achieved by May 1, 1931.

The present proportions for the United States, namely 30 per cent for France and 70 per cent for Germany, are to be continued, at least temporarily, and no immediate changes in the administration or prices are planned for the American markets, it is said, although some relative percentage readjustments are probable for other countries. Both interests will pool their sales promotion activities in world markets, outside of the United States and their prospective home markets.

Leading Market Developments During the Month

German and French producers have announced a new price schedule on potash salts for delivery next season.

Unfair competition by foreign firms will form the basis of a Tariff Commission hearing, May 24.

While spot quotations are unchanged producers of sulphuric acid are reported to be asking higher prices for future deliveries.

Unusually heavy demand has cut down reserve stocks of cottonseed oil and created a strong market.

Reports from abroad say it is doubtful if the German Bromine Convention will be renewed.

Provision is made for a special extra 3,000 ton delivery in the following year by the French Syndicate in case total sales reach only 825,000 tons. Any deliveries above 840,000 will be met by Germany and French Syndicates on an equal basis. If in the first four years the total foreign sales do not reach 840,000 tons, the French producers will receive in the fifth year a preference delivery of 8,000 tons in place of the 3,000 tons bonus. Provided the maximum of 840,000 tons is not reached in the fifth year, then the amount sold in excess of the highest previous annual sales will henceforth be divided on a 50-50 basis. For example, if after four years course of the agreement, peak annual sales reached only 700,000 tons, and if in the fifth year they reached 800,000, the 100,000 tons would be apportioned on an equal basis to each country.

Record annual foreign sales were made by Germany alone, in 1925, with 453,000 metric tons pure potash. If this represents 70 per cent of combined Franco-German foreign sales, it would indicate a joint total of roughly 650,000 tons, or 190,000 tons less than the stipulated total of 840,000.

The second development of the month consisted in the announcement that a new schedule of prices would become effective for domestic deliveries during the coming season. The new prices were quoted as follows. Kainit, 14 to 16 per cent bags, $11.75; bulk, $8.75; kainit, 12.4 per cent, bags, $11.25; bulk, $8.25; manure salts, 20 per cent, bags, $14.85; bulk, $11.85; manure salts, 30 per cent, bags, $21; bulk, $18; potash, magnesia, sulphate (double manure salts), 48 per cent, bags, $26.35; bulk, $25.10; muriate, 80 to 85 per cent, bags, $34.90; bulk, $33.65; sulphate, 90 to 95 per cent, basis 90 per cent, bags, $45.85; bulk, $44.60; all of the foregoing prices per ton, c.i.f. Atlantic and Gulf ports, with discount of 5 per cent on purchases of 50 tons or over, 6 per cent for 100 tons or over, 7 per cent for 300 tons or over and 10 per cent for 500 tons and over. Additional summer shipment discounts on the net prices will be allowed as follows:—4 per cent off net prices on orders received on or before May 15 for shipment May-June, 1926; 2 per cent off net prices on orders received on or before July 1 for shipment July-August, 1926. As an additional inducement to the buyers to place orders for May-September shipment, the sellers will allow such additional rebate on any grade of potash salt shipped from May to September, 1926, inclusive, as will give a differential in price of at least 3 per cent less than the average monthly price of the corresponding grade of potash salt shipped from October, 1926, to April, 1927, inclusive. This differential is to be based on the average list price less quantity discount during the two periods, May to September, and October to April, the rebate to be computed separately on each grade of potash salt, the average differential rebate due buyers to be paid not later than May 31, 1927. On potash ordered for delivery ex-store an extra charge of $1.60 per ton of 2,000 lb. gross weight is added, this charge being net, and providing delivery, f.o.b. cars place of shipment. Quantity discounts are based on tons of actual potash (K_2O). Prices guaranteed against sellers' decline until April 30, 1927.

Lower Contract Prices Expected For Bichromates

Although the contracting period for bichromates is somewhat distant there has been more or less speculation in consuming circles relative to what may be expected in the way of price changes as compared with the quotations named at the beginning of last season. The impression has gained ground that the new prices will be lower than those asked last year. This belief rests on reports that improvements in manufacture will be put into effect and that some producers will be able to turn out bichromates at about one cent per lb. lower than they have been doing. This is not contingent upon any reduction in costs of raw materials but rests solely on changes in the manufacturing process which will reduce overhead or replacement costs. According to these reports one manufacturer already has

Market Conditions and Price Trends

Chem. & Met. Weighted Index of Chemical Prices

Base = 100 for 1913-14

This month	**111.64**
Last month	113.25
May, 1925	112.24
May, 1924	113.60

While there was a tendency toward firmness in many selections, actual price changes had a bearish effect on the weighted index number. Reductions were made in lead salts, sulphate of ammonia, and low prices prevailed for denatured alcohol.

installed new equipment and will have it in operation sometime next month. Based on the position of raw materials there is no reason to suppose that new contract prices will be lower than those of last year. Chrome ore and soda ash are holding a steady price course and sulphuric acid promises to sell at advanced levels. Therefore from a consideration of producing costs in themselves, including fuel and labor, the prospects would favor a higher rather than a lower market for bichromates.

Vegetable Oil Production in Fist Quarter of Year

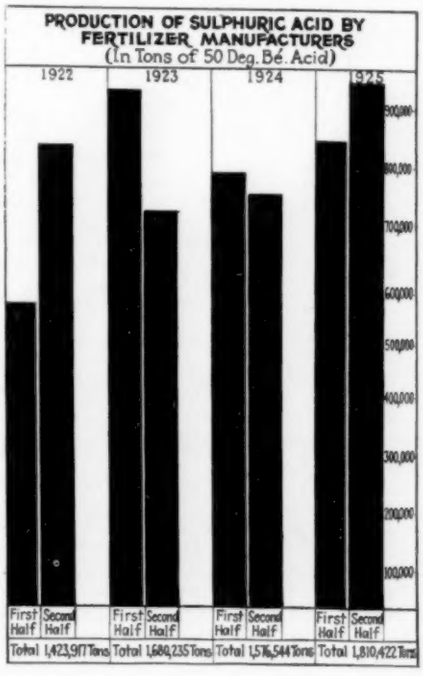
Announcement has just been made by the Department of Commerce that factory production of fats and oils, exclusive of refined oils and derivatives, during the three-month period ended March 31, 1926, was as follows: Vegetable oils, 876,905,865 lb.; fish oils, 7,376,535 lb.; animal fats, 578,252,552 lb.; and grease, 88,800,914 lb.; a total of 1,551,335,866 lb. Of the several kinds of fats and oils covered by this inquiry, the greatest production, 567,614,937 lb. appears for cottonseed oil. Next in order is lard with 462,365,154 lb.; linseed oil with 194,607,038 lb.; tallow with 113,509,554 lb.; coconut oil with 63,088,814 lb.; and corn oil with 33,929,759 lb.

The production of refined oils during the period was as follows: Cottonseed 500,921,044 lb.; coconut 47,406,521 lb.; peanut, 2,170,164 lb.; corn 25,206,201 lb.; and palm-kernel, 2,067,437 lb. The quantity of crude oil used in the production of each of these refined oils is included in the figures of crude consumed.

Data for factory production, factory consumption, and factory and warehouse stocks of vegetable oils for the 3-month period ended March 31, 1926, appear in the following:

Sulphuric Acid Contracts at Higher Prices

Higher producing costs, especially as reflected in recent advances in hte sulphur market, have created an almost general belief that sales schedules for sulphuric acid will be revised upward. For some time the acid market has shown a tendency toward firmness and reports of price cutting which had been prevalent have been conspicuously absent. Supplies in producers possession are said to be ample and there is competition enough among producers to prevent as yet any open marking up of prices. However, the fact that business no longer is going through at private terms under the quoted level of prices in itself is tantamount to an increase in price. The real firmness in the market becomes more apparent from the statement that many acid makers are not covered ahead on sulphur and must place contracts at the present higher figures. This can not fail to result in higher prices for the acid. In fact there are reports in the market that consumers of acid have placed orders recently at higher prices with producers reluctant to accept business where deliveries are extended over more than three or four months. This would indicate that further rises in price were in anticipation for deliveries over the latter part of the year.



The strong position of the sulphur market has caused considerable attention to be directed to pyrites but it is no easy matter to make the changes necessary to use the latter material in acid making and so many factors enter into this consideration that it is doubtful if any relief is to be expected from that direction. It is also pointed out that imports of sulphuric acid are increasing in volume. Official returns show that imports in March were more than double those of March last year and for the 7 months ended March, imports were 34,183,488 lb. as compared with 9,288,042 lb. for the corresponding period last year. Even should imports continue at their present rate, the effect of foreign competition would be negligible as imports would take care of less than one-half of one per cent of domestic requirements. Viewed from all angles the acid market seems destined for higher price levels with producing costs as the dominating factor on values.

The Department of Commerce has announced that, according to data collected at its recent semi-annual canvass, fertilizer manufacturers during the last half of 1925 produced 955,084 tons of sulphuric acid and consumed 1,122,025 tons in the manufacture of 2,046,175 tons of acid phosphates containing 34,535,000 units (of 20 lb.) of available phosphoric acid. The production of sulphuric acid by fertilizer manufacturers was thus equal to 85 per cent of their total consumption. Acid phosphates sold as such amounted to 731,250 tons, containing 12,438,000 units of available phosphoric acid, and 263,372 tons of acid phosphates, containing 4,588,000 units, were consumed in the manufacture of other fertilizers.

PRODUCTION, CONSUMPTION, AND STOCKS OF VEGETABLE OILS

	Production Lb.	Consumption Lb.	Factory and Warehouse Stocks March 31, 1926, Lb.
Cottonseed, crude	567,614,937	592,700,391	90,620,925
Cottonseed, refined	500,921,044	318,670,306	303,678,337
Peanut, virgin and crude	4,000,808	2,791,179	1,115,134
Peanut, refined	2,170,164	2,244,159	1,179,058
Coconut, or copra, crude	63,088,814	87,039,268	62,692,374
Coconut, or copra, refined	47,406,521	45,877,228	12,697,563
Corn, crude	33,929,759	32,035,355	10,266,368
Corn, refined	25,206,201	4,107,166	12,031,492
Soya-bean, crude	990,464	1,377,911	5,537,774
Soya-bean, refined	.....	1,389,749	1,052,115
Olive, edible	1,011,218	293,944	8,067,946
Olive, inedible	17,840	2,457,224	3,375,818
Sulphur oil, or olive foots	.....	8,372,503	5,204,280
Palm-kernel, crude	.....	24,212,692	25,342,941
Palm-kernel, refined	2,067,437	4,090,186	276,806
Rapeseed	73,100	3,250,293	4,589,237
Linseed	194,607,038	98,904,529	190,421,194
Chinese wood or tung	.....	20,449,055	35,822,084
Chinese vegetable tallow	.....	514,368	50,480
Castor	11,209,205	4,819,233	6,067,169
Palm	.....	29,563,593	31,373,958
All other	362,682	1,844,388	4,168,830

Chem. & Met. Weighted Index of Prices for Oils and Fats

Base = 100 for 1913-14

This month	**154.49**
Last month	149.09
May, 1925	153.13
May, 1924	125.88

Steady advances in crude and refined cottonseed oil had a decided influence in moving the weighted index number upward. Higher markets also ruled for corn, oleo, and china wood oils. Tallow and greases were easier.

Current Prices in the New York Market

For Chemicals, Oils and Allied Products

The following prices refer to round lots in the New York Market. Where it is the trade custom to sell f.o.b. works, quotations are given on that basis and are so designated. Prices are corrected to May 15.

Industrial Chemicals

		Current Price	Last Month	Last Year
Acetone, drums	lb.	$0.12 -$0.13	$0.12 -$0.13	$0.10 -$0.11
Acid, acetic, 28%, bbl.	cwt.	3.25 - 3.50	3.25 - 3.50	3.12 - 3.37
Boric, bbl	lb.	.08½- .10	.08½- .10	.09 - .09½
Citric, kegs	lb.	.45 - .47	.45 - .47	.45½- .47
Formic, bbl.	lb.	.10 - .11½	.10 - .11	.10½- .10¾
Gallic, tech., bbl	lb.	.45 - .50	.45 - .50	.45½- .47
Hydrofluoric 30% carb.	lb.	.06 - .07	.06 - .07	.06½- .07
Lactic, 44%, tech., light, bbl.	lb.	.11 - .12	.11½- .12	.13 - .13½
22%, tech., light, bbl.	lb.	.05½- .06	.05½- .06	.06 - .06½
Muriatic, 18°, tanks	cwt.	.80 - .85	.80 - .85	.80 - .85
Nitric, 36°, carboys	cwt.	.05 - .05½	.05 - .05½	.04 - .04½
Oleum, tanks, wks.	ton	18.00 -20.00	17.50 -20.00	16.00- 17.00
Oxalic, crystals, bbl.	lb.	.10¼- .11	.10¼- .11	.10½- .11
Phosphoric, tech., c'bys.	lb.	.07 - .07½	.07 - .07½	.07½- .08
Sulphuric, 60°, tanks	ton	9.50 -10.00	9.50 -10.00	8.00 - 9.00
Tannic, tech., bbl	lb.	.35 - .40	.35 - .40	.45 - .50
Tartaric, powd., bbl.	lb.	.28 - .30	.28 - .30	.29 - .30
Tungstic, bbl	lb.	1.00 - 1.20	1.00 - 1.20	1.20 - 1.25
Alcohol, ethyl, 190 p'f. U.S.P. bbl	gal.	4.90 - 5.00	4.75 - 4.90	4.90 -.....
Alcohol, Butyl, dr.	lb.	18½ - .19	.18½- .19	.27 - .30
Denatured, 190 proof				
No. 1 special dr	gal.	.28 - .40	.30 - .40	.60½-.....
No. 5, 188 proof, dr.	gal.	.32 -.....	.35 -.....	.59½-.....
Alum, ammonia, lump, bbl.	lb.	.03½- .04	.03½- .04	.03½- .04
Chrome, bbl	lb.	.05½- .05½	.05½- .05½	.05½- .06
Potash, lump, bbl.	lb.	.02¾- .03½	.02¾- .03½	.02¾- .03½
Aluminum sulphate, com., bags	cwt.	1.40 - 1.45	1.40 - 1.45	1.40 - 1.45
Iron free, bg	cwt.	2.00 - 2.10	2.00 - 2.10	2.40 - 2.45
Aqua ammonia, 26°, drums	lb.	.03½- .04	.03½- .04	.06½- .06¾
Ammonia, anhydrous, cyl.	lb.	.13 - .15	.13 - .15	.28 - .30
Ammonium carbonate, powd. tech., casks	lb.	.07½- .08½	.08½- .10	.12½- .12¾
Sulphate, wks.	cwt.	2.60 -.....	2.80 -.....	2.75 -.....
Amylacetate tech., drums	gal.	1.80 - 1.90	1.90 - 2.00	2.75 - 3.00
Antimony Oxide, bbl.	lb.	.14½- .15	.16 - .17	.16 - .16½
Arsenic, white, powd., bbl.	lb.	.03½- .04¼	.03½- .04¼	.05 - .05½
Red, powd., kegs	lb.	.12 - .12½	.12 - .12½	.13½- .14
Barium carbonate, bbl.	ton	48.00 -50.00	45.00 -50.00	51.00 -56.00
Chloride, bbl.	ton	63.00 -65.00	63.00 -65.00	66.00 -70.00
Nitrate, cask	lb.	.07½- .08	.08 - .08½	.07½- .08
Blanc fixe, dry, bbl	lb.	.03½- .04	.03½- .04	.03½- .04
Bleaching powder, f.o.b., wks., drums	cwt.	2.00 - 2.10	2.00 - 2.10	1.90 -.....
Borax, bbl.	lb.	.05 - .05¼	.05 - .05½	.05 - .05½
Bromine, cs.	lb.	.45 - .47	.45 - .47	.47 - .48
Calcium acetate, bags	cwt.	3.25 - 3.50	3.25 - 3.50	3.00 - 3.05
Arsenate, dr	lb.	.06 - .07	.06 - .07	.06 - .08
Carbide drums	lb.	.05½- .06	.05½- .06	.05 - .05½
Chloride, fused, dr., wks.	ton	21.00 -.....	21.00 -.....	21.00 -.....
Phosphate, bbl.	lb.	.07 - .07½	.07 - .07½	.06½- .07½
Carbon bisulphide, drums	lb.	.05½- .06	.05½- .06	.06 - .06½
Tetrachloride drums	lb.	.06½- .06½	.06½- .06½	.07 - .07½
Chlorine, liquid, tanks, wks.	lb.	.04 - .04½	.04 - .04½	.04½-.....
Cylinders	lb.	.05½- .08	.05½- .08	.05½- .08
Cobalt oxide, cans	lb.	2.10 - 2.20	2.10 - 2.20	2.10 - 2.25
Copperas, bgs., f.o.b. wks.	ton	15.00 -18.00	13.50- 14.00	13.00 -14.00
Copper carbonate, bbl.	lb.	.16½- .17	.16½- .18	.16½- .17
Cyanide, tech., bbl.	lb.	.49 - .50	.49 - .50	.49 - .50
Sulphate, bbl.	cwt.	4.75 - 5.00	4.50 - 4.60	4.65 - 4.85
Cream of tartar, bbl.	lb.	.21 - .22	.21 - .22	.21 - .21½
Epsom salt, dom., tech., bbl.	cwt.	1.75 - 2.15	1.75 - 2.00	1.75 - 2.00
Imp., tech., bags	cwt.	1.30 - 1.40	1.30 - 1.40	1.35 - 1.40
Ethyl acetate, 85% drums	gal.	.82 - .85	.82 - .85	.90 - .92
99%, dr.	gal.	1.03 -.....	1.03 -.....	1.06 - 1.09
Formaldehyde, 40%, bbl	lb.	.09 - .09½	.09 - .09¼	.09 - .09¼
Furfural, dr.	lb.	.17½-.....	.17½-.....	.23 -.....
Fusel oil, crude, drums	gal.	1.40 - 1.50	1.40 - 1.50	2.70 - 3.00
Refined, dr	gal.	2.50 - 3.00	3.10 - 3.20	4.00 - 4.50
Glaubers salt, bags	cwt.	1.15 - 1.25	1.15 - 1.25	1.20 - 1.40
Glycerine, c.p., drums, extra	lb.	.24 - .25	.24 - .26	.19 - .19½
Lead: White, basic carbonate, dry, casks	lb.	.10½-.....	.10¾-.....	.10½-.....
White, basic sulphate, sck.	lb.	.09½-.....	.10 -.....	.10½-.....
Red, dry, sck	lb.	.12 -.....	.12½-.....	.12½-.....
Lead acetate, white crys., bbl.	lb.	.14½- .15	.14½- .15	.15½-.....
Lead arsenate, powd., bbl.	lb.	.14 - .15	.14 - .15	.13 - .14
Lime, chem., bulk	ton	8.50 -	8.50 -	8.50 -
Litharge, pwd., csk.	lb.	.11½-.....	.11¾-.....	.12½-.....
Lithopone, bags	lb.	.05½- .06	.05½- .06	.06 - .06½
Magnesium carb., tech., bags.	lb.	.06 - .06½	.06½- .06½	.06½- .07
Methanol, 95%, dr.	gal.	.55 - .58	.57 - .62	.65 - .68
97%, dr.	gal.	.57 - .62	.59 - .64	.67 - .69
Nickel salt, double, bbl.	lb.	.10 - .10½	.10 - .10½	.09 - .10
Single, bbl.	lb.	.10½- .11	.10½- .11	.10 - .11
Orange mineral, csk.	lb.	.14 -.....	.14 -.....	.16½-.....
Phosphorus, red, cases	lb.	.68 - .70	.68 - .70	.70 - .75
Yellow, cases	lb.	.34 - .36	.34 - .36	.37½- .40
Potassium bichromate, casks.	lb.	.08½- .08¾	.08½- .08¾	.08¾- .08½
Carbonate, 80-85%, calc., csk.	lb	.06 -.....	.06 -.....	.06 - .06½
Chlorate, powd.	lb.	.08½- .09	.08½- .09	.07½- .08
Cyanide, cs.	lb.	.55 - .57	.55 - .58	.47 - .62
First sorts, csk.	lb.	$0.08½-$0.09	$0.08¾-$0.09	$0.08½-$0.08¾
Hydroxide(c'stic potash) dr.	lb.	.07½- .07¾	.07½- .07¾	.07¼- .07½
Muriate, 80% bgs.	ton	34.90 -.....	34.90 -.....	34.55 -.....
Nitrate, bbl.	lb.	.06½- .06¾	.06½- .06¾	.06 - .07
Permanganate, drums	lb.	.14½- .15	.14½- .15	.14 - .14½
Prussiate, yellow, casks	lb.	.18½- .18¾	.18½- .18¾	.18½- .18¾
Sal ammoniac, white, casks.	lb.	.05½- .06	.05½- .06¼	.05¾- .06
Salsoda, bbl.	cwt.	.95 - 1.00	1.10 - 1.20	1.20 - 1.40
Salt cake, bulk	ton	17.00 -18.00	17.00 -18.00	17.00 -19.00
Soda ash, light, 58%, bags, contract	cwt.	1.38 -.....	1.38 -.....	1.38 -.....
Dense, bags	cwt.	1.45 - 1.55	1.45 - 1.55	1.45 - 1.55
Soda, caustic, 76%, solid, drums, contract	cwt.	3.10 -.....	3.10 -.....	3.10 -.....
Acetate, works, bbl.	lb.	.04½- .05	.04½- .05	.05 - .05½
Bicarbonate, bbl.	cwt.	2.00 - 2.25	2.00 - 2.25	1.75 - 2.00
Bichromate, casks	lb.	.06¾- .06¾	.06½- .06¾	.06½- .06¾
Bisulphate, bulk	ton	5.00 - 5.50	5.00 - 5.50	6.00 - 7.00
Bisulphite, bbl.	lb.	.03½- .04	.03½- .04	.04½- .04¾
Chlorate, kegs	lb.	.06½- .06¾	.06½- .06¾	.06½- .07
Chloride, tech.	ton	12.00 -14.75	12.00- 14.75	12.00 -14.00
Cyanide, cases, dom.	lb.	.18 - .22	.18 - .22	.19 - .22
Fluoride, bbl.	lb.	.08½- .09	.08½- .09	.09 - .09½
Hyposulphite, bbl.	lb.	2.65 - 3.00	2.65 - 3.00	.02½- .02¾
Nitrate, bags	cwt.	2.63 -.....	2.70 -.....	2.65 -.....
Nitrite, casks	lb.	.08½- .09½	.08½- .09	.09 - .09½
Phosphate, dibasic, bbl.	lb.	.03½- .03¾	.03¾- .03¾	.03½- .03¾
Prussiate, yel. drums	lb.	.10 - .10½	.10 - .10½	.10¼- .10¾
Silicate (30°, drums)	cwt.	.75 - 1.15	.75 - 1.15	.75 - 1.15
Sulphide, fused, 60-62%, dr.	lb.	.03 - .03½	.03 - .03¼	.02½- .03
Sulphite, crys., bbl.	lb.	.03 - .03½	.02½- .03	.02½- .03
Strontium nitrate, bbl.	lb.	.08½- .09	.09 - .10	.09½- .10
Sulphur, crude at mine, bulk	ton	19.00 -.....	19.00 -.....	14.00 -16.00
Chloride, dr.	lb.	.05 - .05½	.05 - .05½	.04½- .05
Dioxide, cyl.	lb.	.09 - .10	.09 - .10	.08½- .09
Flour, bag	cwt.	2.70 - 3.00	2.70 - 3.00	2.25 - 2.35
Tin bichloride, bbl.	lb.	.17½-.....	.17½-.....	.15½-.....
Oxide, bbl.	lb.	.66 -.....	.66 -.....	.57 -.....
Crystals, bbl.	lb.	.42½-.....	.42½-.....	.38 -.....
Zinc chloride, gran., bbl.	lb.	.07 - .07½	.07¼- .08	.06 - .07½
Carbonate, bbl.	lb.	.10½- .11	.10½- .11	.12 - .14
Cyanide, dr.	lb.	.40 - .41	.40 - .41	.40 - .41
Dust, bbl.	lb.	.09 - .10	.10 - .10½	.08 - .08½
Zinc oxide, lead free, bag.	lb.	.07½-.....	.07½-.....	.07½-.....
5% lead sulphate, bags	lb.	.07 -.....	.07 -.....	.06½-.....
Sulphate, bbl	cwt.	3.00 - 3.50	3.00 - 3.50	3.50 - 3.75

Oils and Fats

		Current Price	Last Month	Last Year
Castor oil, No. 3, bbl.	lb.	$0.13 -$0.14	$0.13 -$0.14	$0.16½-$0.16½
Chinawood oil, bbl.	lb.	.12 - .12½	.11½- .11½	.12½- .13
Coconut oil, Ceylon, tanks, N. Y.	lb.	.10 -.....	.10½-.....	.09½-.....
Corn oil crude, tanks, (f.o.b. mill)	lb.	.12 -.....	.10½-.....	.10½-.....
Cottonseed oil, crude (f.o.b. mill), tanks	lb.	.12 -.....	.10½-.....	.08½-.....
Linseed oil, raw, car lots, bbl.	lb.	10.8 -.....	10.8 -.....	13.7 -.....
Palm, Lagos, casks	lb.	.08½- .09	.08½- .9¼	.09½- .09½
Niger, casks	lb.	.08½-.....	.08½-.....	.08½-.....
Palm Kernel, bbl.	lb.	.09½- .10	.10 - .10½	.09½-.....
Peanut oil, crude, tanks(mill)	lb.	.10½-.....	.10 -.....	.10½-.....
Perilla, bbl.	lb.	-.....	.15 - .15½	.14½-.....
Rapeseed oil, refined, bbl.	gal.	.84 - .85	.90 - .92	.98 - .99
Sesame, bbl.	lb.	-.....	.15 - .15½	.15 - .15½
Soya bean tank (f.o.b. Coast)	lb.	.10 -.....	.10 -.....	.10½-.....
Sulphur(olive foots), bbl.	lb.	.08½-.....	.08¾-.....	.09½-.....
Cod, Newfoundland, bbl	gal.	.65 - .67	.64 - .66	.62 - .63
Menhaden, light pressed, bbl	gal.	.69 - .71	.69 - .71	.72 - .75
Crude, tanks(f.o.b. factory)	gal.	-.....	.55 -.....	.55 - .58
Whale, crude, tanks	lb.	-.....	-.....	-.....
Grease, yellow, loose	lb.	.07½-.....	.08½-.....	.08¾- .09
Oleo stearine	lb.	.13 - .13½	.12½- .13	.11 - .11½
Red oil, distilled, d.p. bbl.	lb.	.10 - .10½	.11½- .11¾	.11½- .11½
Tallow, extra, loose	lb.	.08 -.....	.08¼-.....	.09½-.....

Coal-Tar Products

		Current Price	Last Month	Last Year
Alpha-naphthol, crude, bbl.	lb.	$0.60 -$0.65	$0.60 -$0.65	$0.60 -$0.62
Refined, bbl.	lb.	.85 - .90	.90 - .95	.75 - .80
Alpha-naphthylamine, bbl.	lb.	.35 - .36	.35 - .36	.35 - .36
Aniline oil, drums, extra	lb.	.16 - .16½	.16 - .16½	.16 - .16½
Aniline salts, bbl.	lb.	.22 - .24	.20 - .22	.20 - .22
Anthracene, 80%, drums	lb.	.60 - .65	.60 - .65	.65 - .70
Benzaldehyde, U.S.P., dr.	lb.	1.30 - 1.35	1.30 - 1.35	1.50 -.....
Benzidine base, bbl.	lb.	.72 - .74	.72 - .75	.78 - .80
Benzoic acid, U.S.P., kgs.	lb.	.56 - .60	.56 - .60	.75 - .85
Benzyl chloride, tech, dr.	lb.	.25 - .26	.25 - .26	.35 - .36
Benzol, 90%, tanks, works	gal.	.24 - .28	.24 - .28	.22 - .26
Beta-naphthol, tech., drums	lb.	.22 - .24	.22 - .24	.24 - .25
Cresol, U.S.P., dr.	lb.	.18 - .20	.18 - .20	.23 - .25
Cresylic acid, 97%, dr., wks	gal.	.60 - .65	.63 - .71	.59 - .62
Diethylaniline, dr	lb.	.58 - .60	.55 - .57	.59 - .61
Dinitrophenol, bbl.	lb.	.31 - .35	.30 - .33	.35 - .38
Dinitrotoluen, bbl.	lb.	.17 - .18	.16 - .17	.18 - .20
Dip oil, 25% dr	gal.	.28 - .30	.28 - .30	.26 - .28
Diphenylamine, bbl.	lb.	.48 - .50	.48 - .50	.48 - .50
H-acid, bbl.	lb.	.65 - .68	.68 - .72	.70 - .74

Coal-Tar Products—Continued

	Current Price	Last Month	Last Year
Naphthalene, flake, bbl. lb.	$0.06½–$0.07	$0.05 –$0.05½	$0.05 –$0.05½
Nitrobenzene, dr. lb.	.09 – .10	.09½– .10	.09 – .10
Para-nitraniline, bbl. lb.	.50 – .53	.50 – .53	.65 – .67
Para-nitrotoluine, bbl. lb.	.30 – .35	.30 – .35	.40 – .42
Phenol, U.S.P., drums lb.	.22 – .24	.22 – .24	.23 – .25
Picric acid, bbl. lb.	.30 – .40	.30 – .40	.20 – .22
Pyridine, dr. lb.	4.75 –.....	4.10 – 4.25	4.10 – 4.20
R-salt, bbl. lb.	.47 – .50	.40 – .44	.50 – .55
Resorcinal, tech, kegs lb.	1.30 – 1.35	1.35 – 1.40	1.30 – 1.40
Salicylic acid, tech., bbl. lb.	.33 – .34	.33 – .34	.32 – .33
Solvent naphtha, w.w.,tanks gal.	.35 –.....	.35 –.....	.24 – .25
Tolidine, bbl. lb.	.90 – .95	.95 – .96	1.00– 1.05
Toluene, tanks, works gal.	.35 –.....	.35 –.....	.26 –.....
Xylene, com., tanks gal.	.36 – .41	.36 – .41	.24 – .26

Miscellaneous

	Current Price	Last Month	Last Year
Barytes, grd., white, bbl. ton	$23.00–$25.00	$17.00–$17.50	$17.00–$17.50
Casein, tech., bbl. lb.	.13½– .14	.13 – .13½	.13 – .14
China clay, powd., f.o.b. Va. ton	10.00 –20.00	10.00 –20.00	12.00 –15.00
Imported, powd. ton	45.00 –50.00	45.00 –50.00	45.00 –50.00
Dry colors:			
Carbon gas, black (wks.) lb.	.08 – .08½	.08 – .08½	.06½– .08
Prussian blue, bbl. lb.	.32 – .33	.32 – .34	.35 – .37
Ultramine blue, bbl. lb.	.08 – .35	.08 – .35	.08 – .35
Chrome green, bbl. lb.	.28 – .30	.28 – .30	.27 – .29
Carmine red, tins lb.	5.10 – 5.25	5.00 – 5.10	4.25 – 4.50
Para toner lb.	.90 – .95	.90 – .95	.95 – 1.00
Vermilion, English, bbl. lb.	1.50 – 1.55	1.40 – 1.45	1.40 – 1.45
Chrome yellow, C. P., bbl. lb.	.17½– .18	.17½– .18	.18½– .19
Feldspar, No. 1 (f.o.b. N. C.) ton	6.00 – 6.50	6.00 – 6.50	6.50 – 7.00
Graphite, Ceylon, lump, bbl lb.	.09 – .10	.08½– .09	.07 – .07½
Gum copal, Congo, bags lb.	.09½– .10	.09½– .10	.08 – .10
Manila, bags lb.	.14 – .16	.14 – .16	.14 – .16
Damar, Batavia, cases lb.	.25 – .25½	.27 – .27½	.28½– .28¾
Kauri, No. 1 cases lb.	.57 – .65	.57 – .65	.58 – .62
Kieselguhr (f.o.b. N. Y.) ton	50.00 –55.00	50.00 –55.00	50.00 –55.00
Magnesite, calc. ton	35.00 –45.00	35.00 –42.00	35.00 –40.00
Pumice stone, lump, bbl. lb.	.04½– .06	.04½– .08	.05 – .05½
Imported, casks lb.	.03 – .40	.03 – .40	.03 – .35
Rosin, H. bbl.	12.50 –.....	13.40 –14.60	8.40 – 8.50
Turpentine gal.	.88 –.....	1.01 –.....	.94 –.....
Shellac, orange, fine, bags lb.	.29 – .30	.40 – .41	.62 – .65
Bleached, bonedry, bags lb.	.33 – .35	.43 – .44	.67 – .69
T. N. bags lb.	.26 – .27	.40 – .41	.58 – .59
Soapstone (f.o.b. Vt.), bags ton	10.00 –12.00	9.50 –10.00	7.50 – 8.00
Talc, 200 mesh (f.o.b. Vt.) ton	11.00 –.....	11.00 –.....	10.50 –.....
200 mesh (f.o.b. Ga.) ton	7.50 –10.00	7.50 –10.00	8.00 –12.00
325 mesh (f.o.b. N. Y.) ton	14.75 –.....	14.75 –.....	14.75 –.....
Wax, Bayberry, bbl. lb.	.20 – .21	.20 – .22	.21 – .21½
Beeswax, ref., light lb.	.46 – .47	.44 – .45	.38 – .39
Candelilla, bags lb.	.36 – .37	.32 – .33	.32 – .33
Carnauba, No. 1, bags lb.	.48 – .50	.48 – .49	.37 – .38
Paraffine, crude 105-110 m.p. lb.	.05¼– .06	.06 – .06½	.06¼–.....

Ferro-Alloys

	Current Price	Last Month	Last Year
Ferrotitanium, 15-18% ton	$200.00–.....	$200.00–.....	$200.00–.....
Ferrochromium, 1-2% lb.	.23– .25	.23– .35	.24–.....
Ferromanganese, 78-82% ton	88.00–90.00	90.00–.....	115.00–.....
Spiegeleisen, 19-21% ton	33.00–34.00	33.00–34.00	32.00–.....
Ferrosilicon, 10-12% ton	33.00–38.00	33.00–38.00	39.50–43.00
Ferrotungsten, 70-80% lb.	1.10– 1.15	1.14– 1.20	.90– ...
Ferro-uranium, 35-50% lb.	4.50–.....	4.50–.....	4.50–.....
Ferrovanadium, 30-40% lb.	3.25– 4.00	3.25– 4.00	3.25– 3.75

Non-Ferrous Metals

	Current Price	Last Month	Last Year
Copper, electrolytic lb.	$0.14½–$0.14½	$0.14½–$0.14½	$0.14¾–$0.15½
Aluminum, 96-99% lb.	.27 – .28	.27 – .28	.27 – .28
Antimony, Chin. and Jap. lb.	.19½– .23	.19½– .23	.20½–.....
Nickel, 99% lb.	.34 –.....	.34 –.....	.31 – .32
Monel metal, blocks lb.	.32 – .33	.32 – .33	.32 – .33
Tin, 5-ton lots, Straits lb.	.62½–.....	.62½–.....	.57½–.....
Lead, New York, spot lb.	8 20 –.....	8.20 –.....	.09½–.....
Zinc, New York, spot lb.	.08 –.....	.08¼–.....	.07½–.....
Silver, commercial oz.	.65½–.....	.67 –.....	.63½–.....
Cadmium lb.	.60 –.....	.60 –.....	.60 –.....
Bismuth, 500-lb. lots lb.	2.70 – 2.75	2.65 – 2.70	1.30 – 1.35
Cobalt lb.	2.50 –.....	2.50 –.....	2.50 – 3.00
Magnesium, ingots, 99% lb.	.75 – .80	1.00 –.....	.90 – .95
Platinum, ref. oz.	112.00–.....	120.00–.....	117.00–.....
Palladium, ref. oz.	78.00– 82.00	87.50– 88.00	78.00–.....
Mercury, flask 75 lb.	87.50–.....	91.00–.....	79.00–80.00
Tungsten powder lb.	1.18– 1.20	1.20–.....	.95– 1.00

Ores and Semi-finished Products

	Current Price	Last Month	Last Year
Bauxite, crushed, wks. ton	$5.50– $8.50	$5.50– $8.50	$5.50– $8.75
Chrome ore, c.f. post ton	21.00– 24.00	22.00– 23.00	18.50– 24.00
Coke, fdry., f.o.b. ovens ton	3.75– 4.25	3.75– 4.25	4.75– 5.00
Fluorspar, gravel, f.o.b. Ill. ton	18.00–.....	16.00– 18.00	17.50– 18.50
Ilmenite, 52% TiO_2, Va. lb.	.01½–.....	.01½–.....	.01½–.....
Manganese ore, 50% Mn., c.i.f. Atlantic Ports unit	.40 – .42	.40 – .42	.42 – .43
Molybdenite, 85% MoS_2 per lb. MoS_2, N. Y. lb.	.55 – .70	.65 – .70	.60– .70
Monazite, 6% of ThO_2 ton	120.00–.....	120.00–.....	120.00–.....
Pyrites, Span. fines, c.i.f. unit	.13½–.....	.13½–.....	.11½– .12
Rutile, 94-96% TiO_2 lb.	.12 – .15	.12 – .15	.12 – .15
Tungsten, scheelite, 60% WO_3 and over unit	12.50 –13.00	12.50 –13.00	9.50 – 9.75
Vanadium ore, per lb. V_2O_5 lb.	.30 – .35	.30 – .35	1.00 – 1.25
Zircon, 99% lb.	.03 –.....	.03 –.....	.06 – .07

Current Industrial Developments

New Construction and Machinery Requirements

New England

Conn., Stamford—Baer Bros., 700-68 Canal St., manufacturers of paints, had plans prepared for the construction of a 2 story, 125 x 132 ft. addition to plant. Estimated cost $75,000. A. Freeman, 29 West 43rd St., New York, N. Y., is architect.

Conn., Stamford—Stamford Gas & Electric Co., 11 Bank St., awarded contract for the construction of a 1 story, 44 x 60 ft. gas plant, 1,000,000 cu.ft. coal gas daily capacity, to West Gas & Improvement Co., 441 Lexington Ave., New York, N. Y. Estimated cost $175,000.

Me., Rockland—Consolidated Cement Co., Chicago, Ill., c/o Great Western Portland Cement Co., Land Bank Bldg., Kansas City, Mo., plans the construction of a cement plant here. Estimated cost $3,000,000. Cowham Engineering Co., 111 West Monroe St., Chicago, Ill., is engineer.

Mass., Adams—New England Lime Co., awarded contract for the design and construction of extension to plant to Dwight P. Robinson & Co. Inc., 125 East 46th St., New York, N. Y.

Mass., Boston—Boston Drug & Chemical Co., Inc., 23-25 Miner St., is in the market for grinder mill for plant.

Mass., Brookfield — McLaurin-Jones Co., manufacturers of gummed paper, is receiving bids for the construction of a 2 story, 65 x 85 ft. factory. Estimated cost $50,000. S. H. Pitcher Co., 44 Front St., Worcester, is architect.

Mass., Cambridge (Boston P. O.)—Lever Bros., Broadway, soap manufacturers, is receiving bids for the construction of a 3 story, 90 x 90 ft. addition to plant. Estimated cost $50,000. C. R. Main, 220 Devonshire St., Boston, is engineer.

Mass., Charlestown (Boston P. O.)—W. F. Schrafft & Sons Corp., 160 Washington St., Boston, confectionery manufacturers, is having preliminary plans prepared for the construction of a 2 story factory, here. Estimated cost $40,000. Lockwood, Greene & Co., 24 Federal St., Boston, are architects.

Mass., Dorchester (Boston P. O.)—Montello Tile & Marble Co. Inc., 54 Geneva Ave., plans the construction of a 1 story addition to factory. Estimated cost $40,000. J. A. Nelly, 698 Massachusetts Ave., Cambridge, is architect. Work will be done by separate contract under the owner's supervision.

Mass., Jamaica Plain (Boston P. O.)—Clifton Mfg. Co., Brookside Ave., manufacturers of rubber goods, awarded contract for the construction of a 1 story factory to W. T. Reed Co., 201 Devonshire St., Boston. Estimated cost $50,000.

Mass., Peabody — Hunt-Rankin Leather Co., Summit St., awarded contract for the construction of a 1 story factory to Roope & Folkins, 73 North St., Salem. Estimated cost $40,000.

Mass., Wellesley — Wellesley College, awarded contract for the construction of a 4 story, 60 x 300 ft. laboratory, to Fred T. Ley Co., 495 Main St., Springfield. Estimated cost $400,000.

Mass., Winchester—Winchester Gelatine Co., E. A. Perkins, Cross St., plans the construction of a 2 story factory. Estimated cost $40,000. Architect not selected.

R. I., Providence—Queen Dyeing Co., 557 Atwells Ave., awarded contract for the construction of a 1 story, 75 x 140 ft. bleachery, to Pierce & Gaetz, Inc., Wilcox Bldg. Estimated cost $20,000.

Middle Atlantic

Del., Wilmington — Tannin Corporation, Greene St., Brooklyn, N. Y., manufacturers of natural tanning extracts, has acquired a site and plans the construction of a plant here.

N. J., Camden—MacAndrews & Forbes Co., manufacturers of licorice, awarded contract for the construction of a 3 story, 56 x 360 ft. factory at 3rd and Jefferson Sts., to Barclay White Co., 1713 Sansom St., Philadelphia, Pa. Estimated cost $150,000.

N. J., Pinewald (mail Bayville) — I. Rokeach & Sons, 345 Hewes St., Brooklyn, N. Y., soap manufacturers, will soon receive bids for the construction of a factory. Estimated cost $150,000. H. J. Nurick, 44 Court St., Brooklyn, N. Y., is architect.

N. J., Trenton—Essex Rubber Co., Beakes and May Sts., awarded contract for the construction of a 1 and 2 story, 65 x 250 ft. and 55 x 250 ft. factory building, to Henry B. Fell Co., 338 Southard St. $83,000.

N. Y., Brooklyn—Pratt Institute, 215 Ryerson St., plans the construction of a laboratory on Steuben St. Estimated cost $300,000.

N. Y., Kenmore—Air Reduction Sales Co., Inc., 730 Grant St., Buffalo, plans the construction of a plant, here. Estimated cost $40,000.

N. Y., Kenmore—Buffalo Electro Chemical Co., River Road, plans the construction of a plant for the manufacture of peroxide. Estimated cost $300,000.

N. Y., Massena—Aluminum Co. of America, Oliver Bldg., Pittsburgh, Pa., is having plans prepared for the construction of a

1 story, 150 x 310 ft. wire mill. Estimated cost $350,000. Private plans.

N. Y., New York—New York University, University Heights, will soon receive bids for the construction of a 4 story chemistry building. Estimated cost $150,000. A. N. Allen, 2 West 45th St., is architect.

N. Y., Yonkers—American Radiator Co., 40 West 40th St., New York, is having plans prepared for the construction of a 2 story laboratory at Bronx River Road, here. Estimated cost $100,000. L. Quick, South Broadway, Yonkers, is architect.

Pa., Lewistown — Pennsylvania Central Light & Power Co., J. H. Shearer, V. Pres. and Gen. Mgr., Union Ave. and 18th St., Altoona, is having surveys made for the construction of a gas plant near here.

Pa., Philadelphia—Bisbee Linseed Co., Drexel Bldg., awarded contract for the construction of a 5 story, 100 x 150 ft. factory at Delaware Ave. and Bigler St., to John N. Gill Construction Co., 121 North Broad St.

Pa., Philadelphia — Glove Dye Works, D. R. Greenwood, Pres., will soon award contract for the construction of a 4 story, 59 x 131 ft. factory at Worth and Kinsey Sts. Stearns & Woodnut, St. Girard Bldg., are architects.

Pa., Philadelphia—Charles Eneu Johnson Co., Tenth and Lombard Sts., manufacturers of printing inks, is having plans prepared for the construction of a 3 story, 60 x 95 ft. factory. Estimated cost $100,000. E. G. Perrot, 1211 Arch St., is architect.

Pa., Philadelphia—La France Textile Co., awarded contract for the construction of a 1 story, 97 x 100 ft. dye house at Orthodox and Large Sts. to Wintz Bros., 1618 Sellers St. Estimated cost $30,000.

Pa., Philadelphia—F. J. Ryan & Co., Wesley Bldg., awarded contract for the construction of an office building and shop for the manufacture and testing of burners and automatic combustion and temperature control device, also standard furnace equipment at Hunting Park and Wissahickon Ave. Complete testing laboratory will be installed.

Pa., Pittsburgh—J. T. and A. Hamilton Co., 26th St., glass manufacturers, awarded contract for the construction of a 1 story, 82 x 120 ft. addition to factory to Thomas Coutts Co., 3332 Smallman St. Estimated cost $40,000.

Pa., Sharon—Sharon Steel Hoop Co., plans the construction of a gas plant and boiler house, also to electrify mills 8 and 16 and remodel unit 14. Estimated cost $500,000. G. S. Warren, c/o owner, Engr.

South

Ala., Birmingham—McMillan Clay Products Co., plans the construction of a plant, daily capacity 75,000 shale building and paving brick.

Fla., St. Petersburg — City will soon award contract for the construction of a gas plant. Estimated cost $75,000.

Ga., Atlanta—City awarded contract for the construction of a chemical house, mixing basin for waterworks, to J. R. Cothran, Candler Bldg. Estimated cost $140,000.

La., Monroe—The Brown Paper Mill Co., G. S. Holmes, V. Pres. and Gen. Mgr., has acquired 150,000 acres of land and plans the construction of addition to mill. Estimated cost $2,000,000. G. F. Hardy, 309 Broadway, New York, N. Y., is engineer.

La., West Monroe—Union Oil Mill Co., awarded contract for the construction of a 1 story, 50 x 360 ft. oil mill to Denham, Vankeuren & Denham, Age Herald Bldg., Birmingham, Ala. Estimated cost $40,000.

N. C., Salisbury—F. A. Tomaline Silk Dye Works, c/o Chamber of Commerce, has acquired a 10 acre site and plans the construction of a dye works. Estimated cost $125,000.

Middle West

Ill., Robinson—Lincoln Oil Refining Co., has acquired 114 acres adjoining its present plant and is having preliminary plans prepared for the construction of a new oil refinery, 5,000 bbls. daily capacity. Estimated cost $2,500,000.

Ind., Gary—Standard Oil Co., is having plans prepared for the construction of an oil refinery. Estimated cost $1,000,000.

Ind., Indianapolis—Swan—Myers Co., 219 North Senate Ave. E., is receiving bids for the construction of a 1 story, 66 x 130 ft. chemical laboratory. Estimated cost $150,000. A. Scherrer, 415 Indiana Trust Bldg., is architect.

Mich., Detroit—Detroit Stove Works, East Jefferson Ave., awarded contract for the construction of a 2 story, 85 x 100 ft. enameling plant in connection with stove factory. C. Kotting, 2306 Dime Bank Bldg., is architect. Enameling equipment for treating stove parts will be required.

Mich., Detroit—Lavigne Brass Co., 5465 Lincoln Ave., is in the market for complete equipment including gas furnace, squeezers, sand blast flasks, etc. for brass factory.

Mich., East Lansing—State Bd. of Agriculture, H. H. Halladay, Secy., will receive bids until May 26 for the construction of a 3 story industrial chemistry building for Michigan State College. Estimated cost $300,000. Bowd & Munson, Lansing, are architects.

O., Cleveland—Max Glick Mfg. Co., M. Glick, Pres., 711 Woodland Ave., candy manufacturers, awarded contract for the construction of a 3 story, 24 x 127 ft. addition to factory to Bolton-Pratt Construction Co., 7113 Euclid Ave. Estimated cost $40,000.

O., Cleveland — Rickersberg Brass Co., S. L. Rickersberg, Secy. & Treas., East 37th St. and Perkins Ave., will soon award contract for the construction of a 1 story, 120 x 236 ft. factory and a 60 x 200 ft. foundry on Kelly Ave. Estimated cost $150,000. Christian, Schwarzenberg & Gaeda, 1900 Euclid Bldg., are architects.

Wis., Madison—University of Wisconsin, J. O. Phillips, Bus. Mgr., is having plans prepared for the construction of a 4 story chemistry building and laboratory. Estimated cost $75,000. A. Peabody, State Capitol, is architect.

Wis., Waukesha — Quality Aluminum Casting Co., Lincoln Ave., awarded contract for the construction of a 1 story, 40 x 120 ft. addition to foundry to P. F. Gierke, 816 Lincoln Ave. Estimated cost $40,000.

West of Mississippi

Kan., Kansas City—United Clay Products Co., Lee Bldg., Kansas City, Mo., plans to remodel and improve plant at 37th St. and Rainbow Blvd. here. Private plans. Machinery will be required.

Kan., Windfield—City plans an election to vote $242,000 bonds for the construction of a gas plant.

Mo., Kansas City—Progressive Brass Mfg. Co., 1711 Cherry St., awarded contract for the construction of a 1 story, 50 x 70 ft. addition to foundry to S. W. Hite, Merriam, Kan. Estimated cost $25,000.

Mo., Kansas City—United Clay Products Co., Lee Bldg., plans the construction of a plant at 26th and Beel Sts. to increase the capacity. Private plans. New machinery will be required.

Mo., Marionville — Apple Growers Vinegar Co., will build a 2 story, 60 x 110 ft. plant by day labor. Estimated cost $30,000. Private plans. Owner is in the market for conveyors, tanks, bottling machines, presses and hydraulic presses.

Okla., Bartlesville — Phillips Petroleum Co., plans the construction of a 3 unit gasoline plant, 3,000,000 sq.ft. daily capacity.

Tex., Abilene—Abilene Cotton Oil Co., will soon receive bids for the construction of a cotton mill, 160 ton daily capacity, including 8 hydraulic presses, 32 linters and steam electric power plant, etc. Estimated cost $250,000. Private plans.

Tex., Amarillo — Gulf Oil Corp., Frick Annex, Pittsburgh, Pa., is considering the construction of an oil refinery here.

Tex., Beaumont—Magnolia Oil Co., plans improvements to present oil refinery, also the construction of 2 new stills. Estimated cost $500,000. Private plans. Work will be done by day labor.

Tex., Edna—Stock Co., c/o Chamber of Commerce, is having preliminary plans prepared for the construction of a fig preserving plant. Estimated cost $35,000. New machinery will be required.

Tex., San Antonio—G. A. Duerler Mfg. Co., 325 West Commerce St., candy manufacturers, will soon award contract for the construction of a 6 story, 140 x 160 ft. factory at Camp St. and Southern Pacific R.R. tracks. Herff & Jones, San Antonia Loan & Trust Co. Bldg., are architects.

Far West

Calif., Berkeley—Pacific Paint & Varnish Co., Wells Fargo Bldg., San Francisco, awarded contract for the construction of a 2 story paint factory here, to Gutleben Bros., 614 Mills Bldg., San Francisco. $45,000.

Calif., Fresno—W. C. Cook & Co. Inc., Clovis, manufacturers of candies, plans the construction of a 2 story, 50 x 150 ft. factory at P. and San Benito Sts. Estimated cost $40,000.

Calif., Merced—Golden State Milk Products Co., 425 Battery St., San Francisco, manufacturers of powdered milk, plans the construction of a plant on State Highway near R. St. Estimated cost $100,000.

Calif., Oakland—Pacific Gas & Electric Co., 245 Market St., San Francisco, awarded contract for the construction of a gas compressor plant on West 50th Ave. to Aust'n & Co., 244 Kearny St., San Francisco. $15,000.

Calif., Pittsburg—Pioneer Rubber Co., 353 Sacramenta St., San Francisco, awarded contract for the construction of a 1 story factory to A. Johnson, 74 New Montgomery St., San Francisco. Estimated cost $75,000.

Calif., San Francisco—Natomas Clay Co., O. B. Perry, 120 Broadway, New York, N. Y., recently organized plans the construction of a plant here for manufacture of clay products.

Calif., Santa Barbara—Southern Counties Gas Co. of California, 311 South Spring St., Los Angeles, plans extensions and improvements to plant here. Estimated cost $250,000.

Wash., Shelton—Rainier Pulp & Paper Co., is having plans prepared for the construction of a 75 ton sulphate pulp mill. V. D. Simons, 431 North Michigan Ave., Chicago, Ill., is architect.

Canada

N. S., Halifax—The Canada Process Fuel Co. Ltd., is in the market for complete equipment for proposed new plant.

Ont., Belleville—Belleville Gas & Fuel Co. Ltd., plans the construction of a carbonizing plant, a 300,000 cu.ft. gas container, also extensions and improvements to distribution system. Estimated cost $200,000.

Ont., Clinton—Huron Milk Products Ltd., W. Miles, Mgr., wants prices and data on complete equipment for proposed new milk powder plant. Estimated cost $100,000.

Ont., Fort Frances—Backus-Brooks Co., 1100 Builders Exchange Bldg., will build a 2 story, 75 x 320 ft. addition to pulp and paper mill by day labor. Estimated cost $1,500,000. J. T. McLellan, Kenora, is engineer.

Ont., Hamilton — Hamilton By-Products Coke Oven Co., awarded contract for the first unit to plant to Tope Construction Co., King St., West Hamilton. Estimated cost $250,000.

Ont., Tillsonburg—Canadian Milk Products Ltd., is in the market for complete equipment for laboratories.

Ont., Wingham—Federal Rubber Co., F. W. Willis, Mgr., wants prices and data on equipment for the manufacture of matting, stair treads, repair kits, vulcanizing equipment and rubber cement for proposed extension to plant. Estimated cost $30,000.

Ont., Woodbridge—Woodbridge Tannery, W. Edwards, Pres., plans to rebuild plant destroyed by fire. Estimated cost $250,000.

Que., Levis — Canadian International Paper Co., Three Rivers, plans the construction of a paper mill here. Estimated cost $5,000,000. A. H. White, c/o owner, is engineer.

Que., Levis—Romaine River Oxide Co. Ltd., is in the market for complete equipment for extensive paint factory. Total cost plant and equipment to exceed $1,000,000.

Que., Montreal—The Ontario Gypsum Co. Ltd., Can. Cement Bldg., Mr. Thringham, Local Rep., is in the market for complete equipment for kettle mill and wall board plant.

Que., Quebec City—Anglo Canadian Pulp & Paper Co. Ltd., having preliminary plans made for the construction of a paper mill. Estimated cost $12,000,000. G. F. Hardy, 309 Broadway, New York, N. Y., is engineer.

Foreign

Australia, Melbourne—Victorian Government Railways, will receive bids until June 2 for 5,000 sets of renewals for caustic soda primary cells.